Micro-Now Instruments

microwave instrumentation
for
research & development

MP MASTER
MA32959

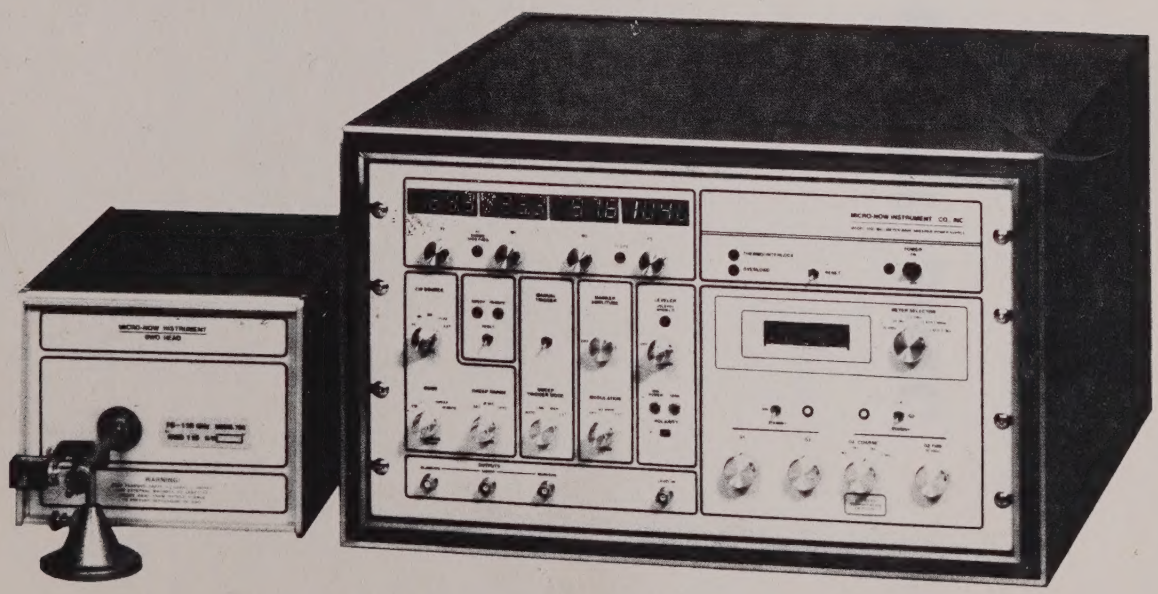
Micro-Now Instrument Co., Inc.
8260 North Elmwood Street, Skokie, Illinois 60077, (312) 677-4700

Micro-Now Instruments

MODEL 705C

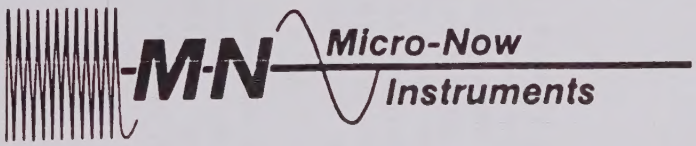
MILLIMETER WAVE SWEEPER SYSTEM

OWNER'S MANUAL



S/N 3150

Micro-Now Instrument Co., Inc., 8260 North Elmwood Street, P.O. Box 1488, Skokie, Illinois 60076, (312) 677-4700
Telex: RCA 297214 MICRO



MODEL 705C

Digitized by the Internet Archive
in 2026

https://archive.org/details/manualsplus_13476

WARRANTY

All our products are warranted against defects in materials and workmanship for one year from the date of shipment. Our obligation is limited to repairing or replacing products (except tubes)* which prove to be defective during the warranty period. We are not liable for consequential damages.

For assistance of any kind, including help with instruments under warranty, contact your Sales Representative or the factory for instructions. Give full details of the difficulty and include the instrument model and serial numbers. Service data or shipping instructions will be promptly sent to you. There will be no charge for repair of instruments under warranty, except transportation charges. Estimates of charges for non-warranty or other service work will always be supplied, if requested, before work begins.

CLAIM FOR DAMAGE IN SHIPMENT

Your instrument should be inspected and tested as soon as it is received. The instrument is insured for safe delivery. If the instrument is damaged in any way or fails to operate properly, file a claim with the carrier or, if insured separately, with the insurance company.

SHIPPING

On receipt of shipping instructions, forward the instrument prepaid to the destination indicated. You may use the original shipping carton or any strong container. Wrap the instrument in heavy paper or a plastic bag and surround it with three or four inches of shock-absorbing material to cushion it firmly and prevent movement inside the container.

* Backward Wave Oscillators are warranted on a pro-rated basis. For Varian BWO's (1) year, for Siemens BWO's (2) years or 2,000 hours, whatever comes first.

MODEL 705C ADDENDA

REVISION AS PER ECN #705208 (Effective on units S/N 2923, 2924, and 2926 and higher.)

The Meter circuit was modified to increase resolution from +/-1 mA to +/-.1 mA on CATH I readings.

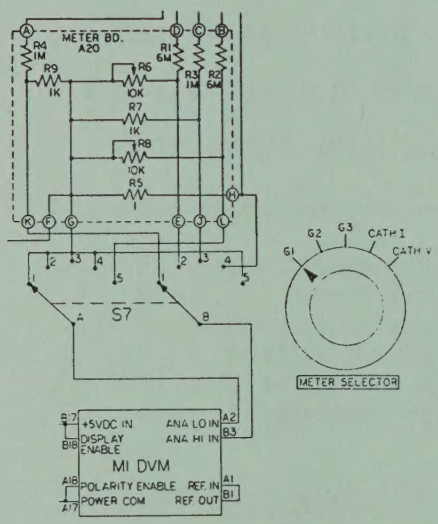
ASSEMBLY A20 METER BOARD (705C20)

On schematic diagram Fig. 7.30 and Parts List Section 8 change:
R5 from 010081 1 ohm, 1/2W, 5%, Carbon Comp.
to 010095 10 ohm, 1/2W, 5%, Carbon Comp. (Fact. Sel. Nom.)

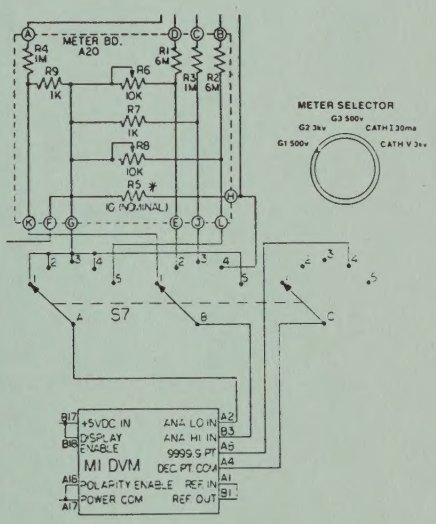
ASSEMBLY - SWITCHES - High Voltage Section

On Parts List Section 8 change:
S7 Meter Selector from 2P, 5 position, 2505
to 4P, 5 position, 2515

On schematic diagram Fig. 7.30 change as shown:



Prior to Modification



After Modification

REVISION AS PER ECN #705213 (Effective on units S/N 2928 and higher.)

The G1 Modulator Board was modified to reduce G1 noise and ripple.

ASSEMBLY A11 G1 MODULATOR BOARD (705C11)

On schematic diagram Fig. 7.11 and Parts List Section 8 change:
R9 from 010217 270 kohm, 2W, 5%, Carbon Comp.
to 010214 150 kohm, 2W, 5%, Carbon Comp.

MODEL 705C OWNER'S MANUAL

TABLE OF CONTENTS

1.0 GENERAL INFORMATION:

- 1.1 Functional Description.
- 1.2 Specifications.
- 1.3 Supplementary Material.
- 1.4 Applications.
- 1.5 Special BWO Heads.

2.0 INSTALLATION AND OPERATION:

- 2.1 Receiving Inspection.
- 2.2 Operating Controls and Indicators.
- 2.3 Operating Instructions.
- 2.4 GPIB (IEEE-488) Interface Operation.
- 2.5 System Operation with External Equipment.
  - 2.51 Oscilloscope Display.
  - 2.52 X-Y Recorder Display.
  - 2.53 Power Meter Display.
  - 2.54 Scaler Network Analyzers.
  - 2.55 Millimeter Wave Frequency Counters.
  - 2.56 Frequency Stabilization.

3.0 ANCILLARY EQUIPMENT:

- 3.1 Siemens Corp. Backward Wave Oscillator Tubes.
- 3.2 Varian Corp. Backward Wave Oscillator Tubes.
- 3.3 Frequency Stabilization.
- 3.4 Pulse Modulation.
- 3.5 Leveling Hardware Requirements.

TABLE OF CONTENTS (CONT'D)

4.0 ADDITIONAL REFERENCE:

- 4.1 Phase Lock Microwave Frequency Stabilizer - Model 211.
- 4.2 Lock Interface For MMW Oscillators - Model 212.
- 4.3 MMW Source Phase Synchronizers - Model 215.
- 4.4 BWO Tube Information.

5.0 TECHNICAL DESCRIPTION:

- 5.1 General System Organization.
- 5.2 Primary Power Distribution.
- 5.3 BWO Power Supplies.
- 5.4 Sweeper Section.
- 5.5 Analog Interface Organization.
- 5.6 General Interface Requirements.
- 5.7 Leveler Amplifier Operation.

6.0 MAINTENANCE AND TROUBLESHOOTING:

- 6.1 Access to Interior.
- 6.2 Periodic Maintenance.
- 6.3 Voltage Measurements.
- 6.4 Internal Adjustments.
- 6.5 Troubleshooting.

7.0 SCHEMATICS AND DIAGRAMS:

8.0 PARTS LISTS:

9.0 SALES AND SERVICE CENTERS:

- 9.1 United States.
- 9.2 Foreign.

LIST OF ILLUSTRATIONS

TITLE	FIGURE NO.
OPERATING CONTROLS & INDICATORS - POWER SUPPLY	2.21
OPERATING CONTROLS & INDICATORS - SWEEP SECTION	2.22
REAR PANEL CONTROLS	2.23
CABINET REMOVAL	2.31
STABILIZATION PHOTOS	3.0
MMW STABILIZATION TESTS	3.2
PULSE MODULATION NETWORK	3.4A
GRID 1 PULSE TEST SET-UP	3.4B
PIN DIODE PULSING	3.4C
705C PRIMARY POWER DISTRIBUTION	5.2
GRID VOLTAGE POWER SUPPLIES	5.3
CATHODE TO HELIX SUPPLY	5.35
SWEEPER AND FREQUENCY CONTROL ORGANIZATION	5.4
LEVELING CIRCUIT SIMPLIFIED SCHEMATIC	5.7
ACCESS TO SYSTEM	6.1
MODULE LOCATION DIAGRAM	6.2
INTERNAL ADJUSTMENTS	6.4
UNITED STATES SALES AND SERVICE REGIONS	9.0

SECTION 1 GENERAL INFORMATION

1.0 GENERAL INFORMATION:

1.1 Functional Description.

1.2 Specifications.

1.21 Sweeper Specifications.
1.22 BWO Power Supply Specifications.

1.3 Supplementary Material.

1.4 Applications.

1.5 Special BWO Heads.

1.0 GENERAL INFORMATION:

1.1 Functional Description.

The Micro-Now Model 705C Millimeter Wave Sweeper System is composed of two sub-systems; the Model 705C Main Frame and the BWO Tuning Head (Models 723 through 733).

The RF frequency band is determined by the BWO tuning head and provides coverage from 18 GHz to 170 GHz. BWO Heads contain the RWO series BWO, an elapsed time meter, cooling fan, and a special thermostat switch mounted directly on the output waveguide flange for over-temperature protection. Table 1.1 is a list of available tuning heads. It shows the frequency band covered, typical output power levels and type of BWO. See also Section 1.5 for special BWO heads.

The Model 705C provides completely independent regulated power supplies for the BWO tube elements: Heater, Cathode to Helix, Grids 1, 2 and 3. Complete front panel metering of all regulated supplies is provided as well as BWO Cathode current. Built in over-current protection and automatic on-off sequencing in event of an overload is also provided.

Digital readouts of both sweep start and stop frequencies and of the two internal marker frequencies are provided. These readouts all have an accuracy of better than 1% from an EPROM individually programmed for each BWO tube. Sweep Rate may be varied from 25 ms to over 100 seconds by an internal microprocessor controlled from the front panel. AM modulation at 1 kHz is provided internally. An RF power leveling amplifier loop using optional external waveguide components is also provided. Provision for external FM or AM is also included.

Table 1.1 BWO Tuning Heads (Siemens BWOs).

Model	Tuning Range (minimum)	RF Output Power (Typical/Min.)	Tube	Flange	Waveguide
733	25-35GHz	200/50 mW	RWO35	UG-599/U	WR-34
729	33-50GHz	100/30 mW	RWO50	UG-383/U (MOD)	WR-22
723	40-61GHz	30/10 mW	RWO60	UG-385/U (MOD)	WR-19
725	50-75GHz	50/10 mW	RWO75	UG-385/U (MOD)	WR-15
724	60-90GHz	30/5 mW	RWO80	UG-387	WR-12
728	75-110GHz	25/4 mW	RWO110	UG-387 (MOD)	WR-10
731	110-170GHz	20/1 mW	RWO170	MIL-F-3922/74-002	WR-6

1.2 Specifications.

1.21 Sweeper Specifications.

FREQUENCY RANGE

18 to 170 GHz with appropriate BWO Head. See Table 1.1.

LEVELING

The Model 705C contains an optically-isolated closed loop feedback system for RF power level control via the Grid 1 element of the BWO. This system requires an optional external RF sampler consisting of a broadband directional coupler and diode mount for proper operation. Selection of leveling with positive or negative output detectors is provided by a front panel switch. Input Z = 2 kohms. Input level = 50 mV. minimum. Flatness, typically +/- 2 dB. full band.

SWEEP MODES

Broadband sweep from F1 to F2 is continuously adjustable anywhere in the frequency range of the BWO. A symmetrical sweep centered about F1 is also provided.

SWEEP RATE RANGE

There are three sweep rate ranges available; Seconds (from about 10 s to over 100 s) for X-Y recordings, Milliseconds (from about 50 ms to 6 s) for use with scalar network analyzers, and Special (fixed at 25 ms) for direct visual observation of sweeps.

SWEEP TRIGGERING

Auto, line, external and manual sweep triggering modes are provided.

CW OPERATION

Four stable single frequencies may be set with F1, F2, M1 and M2 controls, and selected by a front panel switch. External stabilization by rear panel connector is provided for use of a frequency/phase lock device for ultra-stable RF signal generation. Typical CW frequency stability is approximately +/- .01% of BWO operating frequency.

REMOTE FREQUENCY CONTROL

Remote frequency control is provided by the IEEE 488 interface bus, or by application of a dc control voltage to the external sweep input jack.

SWEEP OUTPUTS

Two sweep output signals are provided: a constant amplitude 0 to +10 volt signal is provided at the front panel to drive X-Y recorders or oscilloscopes during sweep functions; and a proportional sweep, directly related to the output frequency, is available at the rear panel.

MANUAL SWEEP

The F1 to F2 sweep may be made manually. During manual sweep the sweep output varies linearly from 0 to +10V.

BLANKING OUTPUT

A +5 volt signal is provided during sweep retrace time.

PEN LIFT

An uncommitted set of relay contacts (SPDT) operates during retrace time at the slow sweep rate. Retrace is delayed 250 ms in Seconds Sweep Rate Mode to allow the pen to lift before retrace is begun.

BLANKING ON/OFF DURING RETRACE

When on, RF power is turned off (blanked) during retrace; when off, RF power is not blanked during retrace.

FREQUENCY MARKERS

M1 and M2 frequency markers are available as either pips in the RF signal or as negative going signals from +5 volt via front panel BNC connector.

FREQUENCY STABILITY

Typically better than .01% after BWO warmup.

INTERNAL AM

Square wave adjustable about 1 kHz, 600 to 3000 Hz.

EXTERNAL AM

A +5 volt input signal will turn the BWO RF power on via Grid 1 Modulator. Rise time is 50 usec. and fall time is 30 usec., for a maximum frequency of 10 kHz.

EXTERNAL FM

0 to 50 volts deviates the BWO frequency over its full range. Response is from dc to about 100 Hz in CW mode and 15 kHz in sweep modes.

EXTERNAL SWEEP

A 0 to +5 V dc input will sweep the BWO frequency over its full range.

POWER INPUT

105 to 125 V ac or 210 to 250 V ac, 50-60 Hz. Approximately 350 voltamperes.

CATHODE SUPPLY VOLTAGES

Three cathode to helix supply voltage ranges are available to cover the useful operating of range of all Siemens and Varian Corp. Millimeter Wave BWOs.

SIZE/WEIGHT

21"W x 21"D x 12"H. (53.3 x 53.3 x 30.5 cm.)
100 lbs. (45.4 Kg.), including cabinet.

1.22 BWO Power Supply Specifications.

CATHODE TO HELIX SUPPLY

VOLTAGE:	Three ranges are available to cover the useful operating ranges of all Siemens RWO series BWO tubes; -340 to -1685 V dc nominal, -550 to -2650 V dc, and -600 to -3000 V dc nominal. These voltage ranges are selected by placement of a jumper on the rear panel of the 705C (see Section 2.25). **WARNING: HV must be OFF when selecting range. Damage to operating personnel and/or BWO may result if HV jumper is changed with HV ON.**
CURRENT:	20 mA.
RIPPLE:	Less than 50 mV p-p.
REGULATION:	Load, less than 1 V., no load to full load Line, +/-0.1% for +/-10V line variation.
FLY BACK TIME:	14 ms minimum in Special Mode.
PROTECTION:	Overcurrent relay in Helix return line set for 20 mA operation.

GRID 1 SUPPLY/MODULATOR

VOLTAGE:	-160 to -300 V dc; -160 to -430 V dc for RF blanking. (nominal)
CURRENT:	3 mA.
RIPPLE:	Less than 10 mV p-p.
REGULATION:	.02%
MODULATION:	Rise and fall time, 50 microsec.

GRID 2 SUPPLY

VOLTAGE:	1000 to 3000 V dc in 500 V steps. Fine control, 10 turn pot, 500 volt variable.
CURRENT:	2 mA.
RIPPLE:	Less than 20 mV p-p.
REGULATION:	.02%
PROTECTION:	Overcurrent relay in series with output. Set for 2 mA operation.

GRID 3 SUPPLY

VOLTAGE:	170 to 420 V dc (nominal).
CURRENT:	10 mA.
RIPPLE:	Less than 10 mV p-p.
REGULATION:	.02%
PROTECTION:	Overcurrent relay in series with output. Set for 7 mA operation.

HEATER SUPPLY

VOLTAGE:	4 to 7 V ac.
CURRENT:	1.5 A
REGULATION:	.02%, line and load.

MICROPROCESSOR SUPPLY: (Lambda Model Lot-X-5152-A)

OUTPUTS:	+5 V @3.0 A
	+12 V @0.5 A
	-12 V @0.5 A

LINE REGULATION:	0.15% for +/-10% line change (all)
LOAD REGULATION:	0.15% no load to full load (all)
RIPPLE AND NOISE:	5 mV p-p.

1.3 Supplementary Material.

Located in the rear of this manual is supplementary material which relates directly to this particular instrument. Special revisions, if required by the customer, will be found in this section. Also provided will be manufacturers' data sheets relating to the BWO tube or tubes ordered with the system, and any other pertinent data generated at time of final testing.

1.4 Applications.

The Model 705C can provide for practically any requirement of a millimeter wave signal source. Frequency coverage extends from below 30 GHz to 170 GHz in full waveguide bands. This versatile instrument offers: Full band sweep, stable fixed frequency operation, and both FM and AM modulation, all under computer control. Operation is possible with all popular scalar network analyzers, with frequency and phase synchronizers, and with some types of vector network analyzers. Section 2.5 gives detailed operating instructions for the various operating modes.

1.5 Special BWO Heads.

In addition to the RWO series of BWOs listed in Table 1.1 the Model 705C can operate with BWOs from several other manufacturers such as Varian and Watkins-Johnson. As an example, tuning heads Models 735, 736, and 737 incorporate special circuitry which allow Varian BWOs in the frequency ranges from 18 to 50 GHz to be powered directly.

Since these tubes require a much lower Cathode to Helix voltage than do the Siemens tubes, the 705C has provision to modify this voltage by the simple placement of a rear panel jumper wire. See Section 2.25 for further details.

SECTION 2 INSTALLATION AND OPERATION

2.0 INSTALLATION AND OPERATION:

2.1 Receiving Inspection.

2.11 Power Requirements.
2.12 Chassis Grounding.
2.13 Cooling.
2.14 Frequency Dials - EPROMs.
2.15 Initial Tests.

2.15.1 Dial and Calibration Tests.
2.15.2 Sweep Voltage Test.
2.15.3 Triggering Test.
2.15.4 Modulation Test.

2.16 Returning the Instrument.

2.2 Operating Controls and Indicators.

2.21 Front Panel Power Supply Controls.
2.22 Front Panel Power Supply Indicators.
2.23 Front Panel Sweep and Frequency Controls.
2.24 Front Panel Sweep and Frequency Indicators.
2.25 Rear Panel Controls.
2.26 Front and Rear Panel Interfaces.

2.3 Operating Instructions.

2.31 Installation.
2.32 Rack Mounting.
2.33 Turn On Procedure.

2.33.1 BWO Heater Adjustment.
2.33.2 CW Operation.
2.33.3 Swept Operation.
2.33.4 Narrow Band Symmetrical Sweep (Delta-F Mode).
2.33.5 Special Sweep Rate Mode.
2.33.6 RF Output Modulation.
2.33.7 Leveling Operation.
2.33.8 BWO Operation After Long Idle Periods.

2.4 GPIB (IEEE-488) Interface Operation.

2.41 Setting the Output Frequency Via the Bus.
2.42 Test Programs.

SECTION 2 INSTALLATION AND OPERATION

2.5 System Operation with External Equipment.

2.51 Oscilloscope Display.
2.52 X-Y Recorder Display.
2.53 Power Meter Display.
2.54 Scalar Network Analyzers.
2.55 Millimeter Wave Frequency Counters.
2.56 Frequency Stabilization.

2.0 INSTALLATION AND OPERATION:

2.1 Receiving Inspection.

Upon receiving your Model 705C, carefully unpack the instrument and check for shipment damage. If some damage is evident, file a claim against the carrier.

If no shipping damage is evident, read the instructions that follow, and perform an operating test of the instrument.

2.11 Power Requirements (See Figures 6.0 and 6.3).

The unit is normally wired and tested at the factory for the line voltage specified by the original customer. Provisions are made for easy conversion between the 120 V ac nominal and 240 V ac nominal operation. With the top cover removed, locate the power conversion switch and its locking plate. The locking plate will be labeled with the operating voltage. Remove the plate and move the switch to its alternate position. Turn the plate over and replace it with the proper voltage showing. The F1 fuse, accessed from a holder at the rear of the unit, must also be changed at this time. The alternate fuse value is given near the F1 fuse holder.

2.12 Chassis Grounding.

The instrument is supplied with a three-conductor power cord and a three prong power plug, which grounds the instrument when plugged into an appropriate receptacle. Failure to properly ground the instrument can degrade its performance and permit a voltage dangerous to operating personnel to build up on the chassis.

2.13 Cooling.

The high voltage pass tube and microcomputer power supplies require unrestricted air circulation. Adequate space must be provided at the rear of the unit for cooling purposes.

2.14 Frequency Dials - EPROMs.

Micro-Now provides a calibrated EPROM for each BWO supplied from the factory. EPROMs are available at an additional cost for BWOs not supplied by Micro-Now. Micro-Now "burns in" the EPROMs at the factory to provide calibration of the digital readouts for the BWO's operating frequencies. The correct EPROM must be selected if the correct frequency dial for the BWO is to be used. Each EPROM is designated by an attached label showing tube type and tube serial number (e.g. "RWO110S S/N 227").

2.14 Frequency Dials - EPROMs (Cont'd).

An EPROM Select Board (A7) is provided within the Model 705C with space for five (5) EPROMs. Automatic selection is accomplished by grounding one or more lines within the BWO housing at the BWO power connector, J66, to indicate which EPROM is to be used with the BWO enclosed.

If there is no selection line within the BWO head, Socket A will be selected. Socket A is a zero-insertion force socket on the Manual EPROM Board (A24) located on the rear panel and connected to the EPROM Select Board via a 24-conductor cable. It is accessible from the rear of the unit. If there is no EPROM in any of the sockets, a 0 to 100% logging scale will be automatically operational. This 0 to 100% logging scale is programmed into the firmware of the 705C's Microcomputer Board (A1).

Listed in the table below are the suggested connections, from pins F, H, and/or J to pin K (ground), to be made inside the BWO housing at the BWO power connector for the most popular of the Siemens series of millimeter wave BWOs. It should be used only as a guide to keep EPROMs and BWOs compatible.

The EPROM Select Board (A7) is accessed by removing the main unit from its protective cabinet, see Figure 2.31. Viewed from the front, the cover plate to the EPROM Select Board is on the left side panel. Removing the plate yields access to EPROM Sockets B, C, D, and E. The EPROM must be inserted into the socket selected by the connections at the BWO power connector, J66, if the correct dial is to be used. Replace the access panel, slide the unit back into its cabinet, and secure the unit with its mounting hardware.

2.14 Frequency Dials - EPROMs (Cont'd).

EPROM SELECTION TABLE

EPROM SOCKET SELECTED	BWO POWER CONNECTOR (J66) WIRING			RWO TYPES (SUGGESTED)
	PIN F	PIN H	PIN J	
A	0	0	0	REAR PANEL, ANY RWO
B	1	0	0	RWO 35, RWO 50
C	0	1	0	RWO 50, RWO 60, RWO 75
D	1	1	0	RWO 75, RWO 80, RWO 110
E	0	0	1	RWO 110, RWO 170
---	NO EPROM			AUTOMATIC 0-100% LOGGING

[(1) tie this (these) pin(s) to ground, pin K]

2.15 Initial Tests.

Many of the internal adjustments located within the Model 705C chassis are critical. They have been carefully factory-adjusted prior to shipment and should not need field adjustment. The following inspection test may be performed prior to regular operation of the unit.

2.15.1 Dial and Calibration Tests.

Set the CW source switch to F1 and the Mode switch to CW. Do not connect a BWO tube or dummy load. Turn the power switch on. There is a slight delay, less than one second, to allow the microcomputer to initialize itself. The digital readouts display meaningless numbers during this delay. After the delay the frequency displays will display the control position of all four frequency controls from 00.0 to 100.0 percent.

When a BWO is connected to the system (set the BWO heater voltage to 6.3 V ac) these digital dials will display the correct frequency range for the connected tube, if the BWO housing is correctly jumpered and the proper dial is present.

2.15.2 Sweep Voltage Test.

Set the Mode switch to sweep and connect an oscilloscope to the Sweep Output jack using dc coupling. Set F1 to minimum and F2 to its maximum value. Set the Sweep Rate Range switch to its center position and the Sweep Rate control fully CW. Set the trigger mode switch to Auto. The signal observed on the oscilloscope should be a sawtooth of approximately 10 volt peak to peak amplitude.

2.15.3 Triggering Test.

Observe the sweep waveform with a triggered sweep oscilloscope. With the 705C in auto mode, the sweep will free run. In line trigger mode it will also be possible to trigger the oscilloscope in its line mode, and synchronize the sweep display. In manual trigger mode the sweep will continue only while the manual trigger switch is activated.

2.15.4 Modulation Test.

Place a jumper connection at thermo/interlock on BWO connector pins M and N. (See Fig. 7.33). Set the high voltage and G2 power switches to their off position and wait out the two minute high voltage section time delay. Set the G1 control fully CW and the meter switch to G1. Set the Modulation switch to off. When the HV standby light illuminates, turn the high voltage on. Observe the G1 voltage. Turn the modulation to square; the G1 voltage should swing about 50 volts more negative.

2.16 Returning the Instrument.

If it becomes necessary to return the instrument to Micro-Now Instrument Co. authorization must first be obtained from our service department. This authorization is a formality required to insure that we expect the instrument and understand why it is being returned. Instructions for packing and shipping the instrument will be given at that time.

2.2 Operating Controls and Indicators.

2.21 Front Panel Power Supply Controls (See Figure 2.21).

POWER ON/OFF SWITCH

Turns main power on or off.

OVERLOAD RESET SWITCH

Resets the high voltage supplies after the operator corrects the overload condition.

METER SELECTOR SWITCH

Selects one of five positions to set or monitor BWO operating conditions. G1, G2 and G3 positions monitor these respective grid voltages. Cath I monitors the cathode current of the BWO and the Cath V monitors the Cathode to Helix voltage.

HIGH VOLTAGE ON/STANDBY SWITCH

Turns the G1, G3 and Cathode to Helix voltage on or off after the BWO heater warm up time delay.

G1 VOLTAGE VERNIER CONTROL

Sets the correct Grid 1 voltage for the BWO tube in use.

G3 VOLTAGE VERNIER CONTROL

Sets the correct Grid 3 voltage for the BWO tube in use.

G2 VOLTAGE ON/STANDBY SWITCH

Turns the G2 voltage on or off after the high voltage switch is turned on.

G2 COARSE SELECTOR SWITCH

Selects the minimum voltage for the G2 supply. Four 500 V ranges are provided from 1000 to 2500 V dc.

2.21 Front Panel Power Supply Controls (Cont'd) (See Figure 2.21).

G2 FINE VERNIER CONTROL

Increases the minimum voltage selected by the coarse control. The coarse switch and the fine vernier are used together to set the correct G2 voltage for the BWO tube in use.

2.22 Front Panel Power Supply Indicators (See Figure 2.21).

THERMO/INTERLOCK LED

Flashes red when either the unit's top cover is removed (open interlock) or the BWO thermal switch is open (BWO not connected or overheated).

OVERLOAD LED

Flashes when the Grid 2, Grid 3 or BWO Cathode draws excessive current and trips the overload protection circuits, shutting down the high voltage supplies.

METER

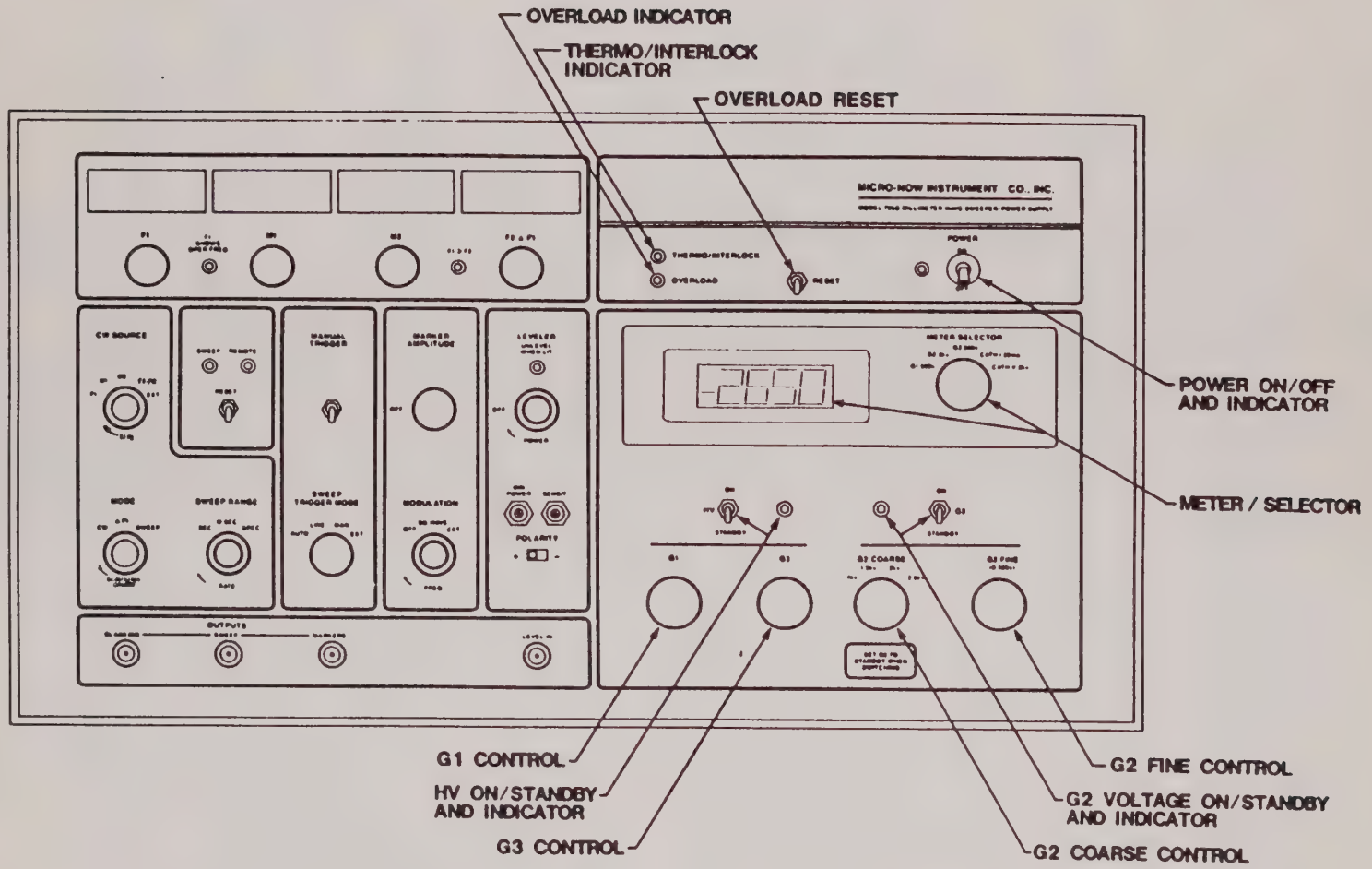
Measures voltage or current according to the Meter Selector Switch position.

HIGH VOLTAGE ON/STANDBY LED

Glows green when the high voltage supplies are available but not turned on; glows red when they are turned on.

G2 ON/STANDBY LED

Glows green when the G2 supply is available but not turned on; glows red when it is turned on.



MODEL 705C

OPERATING CONTROLS & INDICATORS - POWER SUPPLY

Figure 2.21

2.23 Front Panel Sweep and Frequency Controls (See Figure 2.22).

FREQUENCY VERNIER CONTROLS, F1 and F2

In sweep mode determine the lower and upper limits of the sweep. In CW mode, selects single frequency operating point.

MARKER VERNIER CONTROLS, M1 and M2

In sweep mode, provides adjustable marker pips, if adjusted to frequencies within the swept range.

CW SOURCE SELECTOR SWITCH AND MANUAL SWEEP (F1-F2) CONTROL

The CW Source switch selects the vernier that controls the output frequency in CW mode or the center frequency in Delta-F mode. In external source position, the operating frequency may be controlled by a voltage applied to a sweep input BNC.

The Manual Sweep (F1-F2) control, concentric with the CW Source switch, functions only when the CW Source switch is in the F2 position and the Mode switch is in the CW position. Concentric with the CW Source switch, this control can be turned clockwise to manually sweep the RF output from F1 to F2.

MODE SELECTOR SWITCH AND BLANKING ON/OFF SWITCH

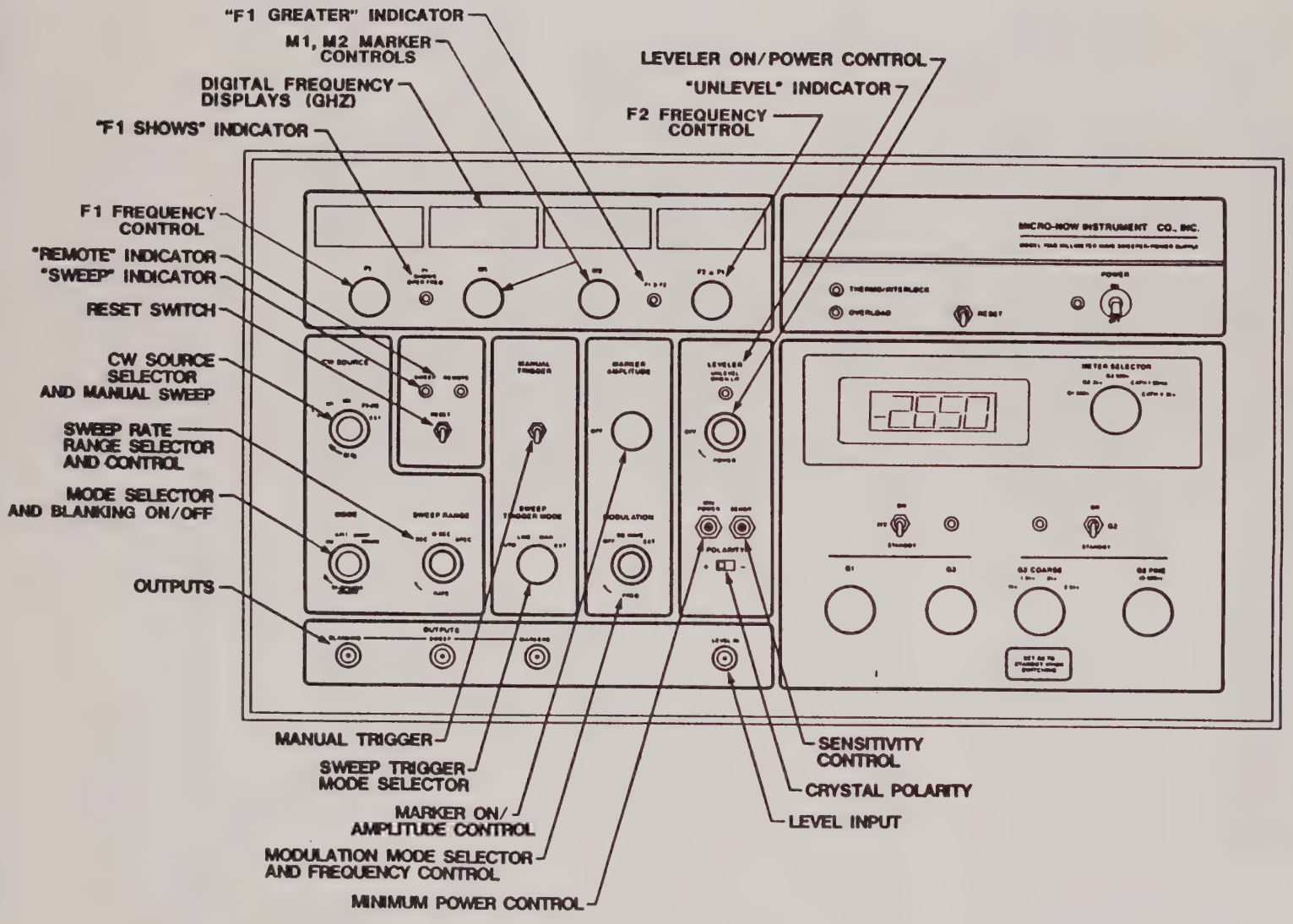
The Mode selector switch selects between CW (single frequency), Delta-F (symmetrical sweep about a center frequency), Sweep (F1 to F2 sweep) modes, or Remote Modes.

The Blanking On/Off switch, concentric with the Mode switch, is operational only in swept frequency modes of operation. In the off position, RF power is supplied during retrace.

SWEEP RANGE SELECTOR SWITCH AND RATE CONTROL

The Sweep Range selector switch selects between Seconds, Milliseconds, and Special Sweep Rates.

The Rate control is concentric with the Sweep Range switch. When rotated clockwise it decreases the sweep time. In Seconds it continuously changes the sweep rate during a sweep. It does not affect the sweep rate in Special position.



MODEL 705C
OPERATING CONTROLS & INDICATORS - SWEEPER SECTION

Figure 2.22

RESET SWITCH

When activated it reinitializes the computer in the 705C unit and then begins to execute the front panel controlled instructions.

SWEEP TRIGGER MODE SELECTOR SWITCH

In auto position, the sweep retriggers itself. In line position, the sweep is triggered in synchronization with the ac line frequency. In manual trigger, the sweep is triggered by the manual trigger switch. In external position a positive TTL level trigger pulse applied to the external trigger BNC connector triggers the sweep; if no pulse generator is connected, it freeruns.

MARKER ON/AMPLITUDE CONTROL

Turns the markers on and sets the amplitude of the markers that are visible in the RF output during F1 to F2 sweep.

MODULATION MODE SELECTOR SWITCH AND FREQUENCY CONTROL

The Modulation mode selector switch in the off position eliminates all amplitude modulation. In square wave position, an internal square wave generator modulates the RF power output. In external position, the RF power output may be modulated by a TTL level signal applied to the External AM modulation BNC, if no generator is connected the BWO tube is cutoff via G1.

The Frequency control is concentric with the Modulation mode selector. In square wave mode this control sets the modulation frequency at about 1 kHz.

LEVELER ON SWITCH/POWER CONTROL

The Power control sets the leveled power output of the BWO. Power level is adjusted from no leveling (cw) to maximum leveling (ccw). The Leveler On switch turns off leveling circuit when fully ccw.

MINIMUM POWER VERNIER CONTROL

Recessed behind the front panel, this control sets the minimum leveled power.

2.23 Front Panel Sweep and Frequency Controls (Cont'd) (See Figure 2.22).

SENSITIVITY CONTROL

Recessed behind the front panel, this control sets the gain of the power leveling control loop.

CRYSTAL POLARITY SWITCH

Sets the polarity according to the power detector used in the leveling system.

2.24 Front Panel Sweep and Frequency Indicators (See Figure 2.22).

DIGITAL FREQUENCY DISPLAYS

Shows the frequency that corresponds to the setting of the nearby control. The F1 display also shows the operating frequency in Seconds Sweep Rate Mode, or the control number that was sent to the instrument by the controller in Remote Mode. The F2 display shows the percent of tube bandwidth of the sweep in Delta-F Mode.

"F1 SHOWS OPERATING FREQUENCY" LED

In seconds sweep mode, the F1 display is updated to show the current output frequency.

"F1 GREATER THAN F2"

The unit will not sweep backwards. This LED indicates when this error condition has been established.

"SWEEP" LED

In Sweep Mode indicates that the unit is in a sweep cycle and that the BWO tube is turned on. In Remote Mode it indicates that the BWO is turned on.

"REMOTE" LED

Indicates that the unit has been addressed by a controller on the GPIB.

"UNLEVELED WHEN LIT" LED

Indicates that the RF power output is not leveled.

2.25 Rear Panel Controls (See Figure 2.23).

HEATER VOLTAGE

Sets the ac heater voltage when a Siemens BWO tube is connected; does not effect the heater voltage when Varian tubes are connected.

GPIB ADDRESS

Use to set the primary address, in binary code, for the unit's GPIB.

EPROM SOCKET

If there is no select line within the BWO head, this Socket "A" will be selected. See Section 2.14 for details.

BLANKING RELAY SWITCH

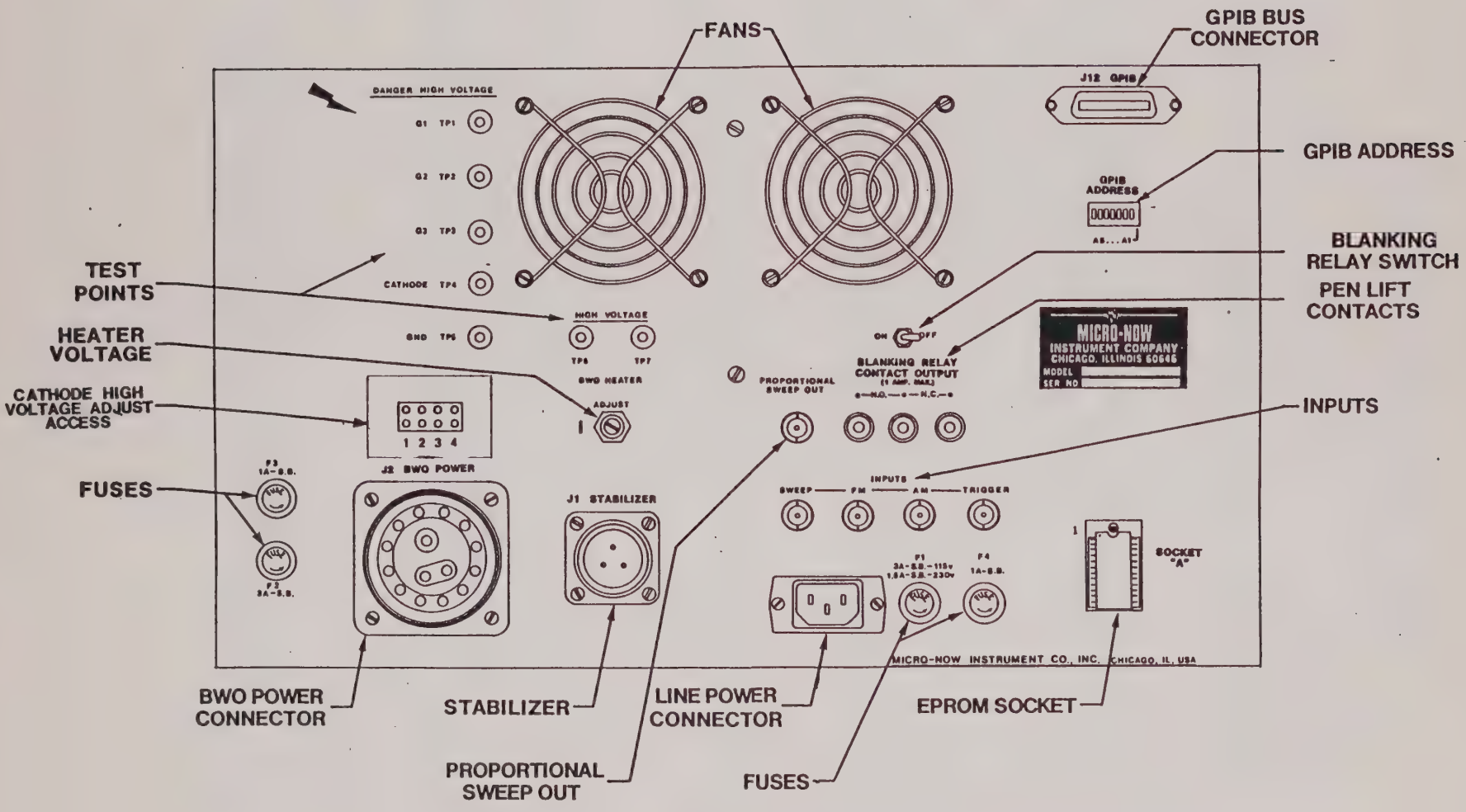
Enables or disables pen lift relay.

CATHODE HIGH VOLTAGE ADJUST ACCESS

Removing the plate yields access to a pin jumper that is used to select one of three available voltage ranges depending on the range required for tube being used:

Position	Voltage Range
1	-340 to -1685 V dc nominal
3	-550 to -2650 V dc
2,4	-600 to -3000 V dc nominal

WARNING: HV must be OFF when selecting range. Damage to operating personnel and/or BWO may result if HV jumper is changed with HV ON.



MODEL 705C

REAR PANEL CONTROLS

Figure 2.23

2.26 Front and Rear Panel Interfaces.

Front Panel (See Figure 2.22).

BLANKING

This BNC connector provides a logic one TTL level output to blank an oscilloscope trace during RF sweep retrace.

SWEEP

This connector provides a constant amplitude sawtooth in Sweep or Delta-F modes. May be used for driving the horizontal axis of an X-Y recorder or oscilloscope, about 0 to +10 V in Sweep mode. It is also active in CW mode and may be used for Manual Sweep output.

MARKERS

Provide a negative TTL level when the output frequency is coincident with a marker frequency setting.

LEVEL IN

The voltage sample from a power detector is connected here, when the 705C unit is to be leveled.

Rear Panel (See Figure 2.23).

TEST POINTS

Seven pin-jack type test points are provided for monitoring the voltages on the BWO tube.
CAUTION: Do not use a line operated meter. Meter must be isolated from external grounds. All voltages at TP1, 2, 3, 6, and 7 are with respect to the HV Cathode Supply. Make connections and disconnect with the HV OFF to prevent shock to operating personnel.

STABILIZER

An HV connector is provided to permit external modulation of the G2 voltage by a klystron style frequency stabilizer. In unstabilized operation, a shorting plug is connected here. The stabilizer must be capable of isolated HV operation up to 3000 volts.

Rear Panel (Cont'd).

PROPORTIONAL SWEEP

A voltage proportional to the operating frequency according to the percentage of tube bandwidth is output here. 0 V = minimum frequency, +5 V = maximum.

EXTERNAL SWEEP

External control input for operating frequency in CW or Delta-F modes. Voltage range is 0 to +10 V. Limited frequency bandwidth in CW mode.

FM

Direct dc connection to the input of the Cathode to Helix Supply. If the selected frequency control is set to minimum, a dc signal from 0 to +50 volts will drive the supply through the full range. Recommended operation is +/- 5 V dc, which will deviate the operating frequency about that selected region within the BWO operating range. This input is always connected and has maximum bandwidth when the CW signal filter is automaticaly disconnected in the Delta-F and Sweep modes.

AM

TTL level modulation in EXT. AM Mode has a 50 usec. rise time and a 30 usec. fall time, 100% square wave modulation is possible to a maximum frequency of 10 kHz.

TRIGGER

TTL level input for external triggering of sweep. A logic one or an open circuit triggers the sweep.

PEN LIFT CONTACTS

The common, n.o., and n.c. contacts of a relay, driven from the BWO tube RF on/off signal, are available here. They are rated for 1 A at 120 V ac.

BWO POWER CONNECTOR

Provides interface to BWO Head.

GPIB BUS CONNECTOR

Provides interface to computer.

LINE POWER CONNECTOR

Provides 120/240 V ac line connection.

2.3 Operating Instructions.

2.31 Installation.

The Model 705C must be installed in a location which allows sufficient space behind the rear and at the sides of the unit for unrestricted air flow in and out of the cabinet.

The BWO head is connected to the unit using the special cable shipped with the system. The connectors must be completely engaged (about 8 or 9 full turns) to ensure good contact at all pins.

EPROMs are provided for each BWO to be serviced. These devices provide automatic calibration of the digital readouts for the BWO's operating frequencies. The correct EPROM must be selected for the tube in use, either through the automatic selection provisions, or through the rear panel socket. EPROMs are designated by attached labels showing tube type and serial number (e.g. "RWO110N S/N 0303").

The power cord, connected to the rear of the 705C system through a standard socket, is equipped with a three prong plug and insures that the system frame will be grounded when it is plugged into the correct receptacle. It is important that a proper ground be provided to afford protection to operating personnel. The unit is shipped from the factory to operate from 120 V ac, 50-60 Hz. However, operation at 240 V ac is provided for by an internal change-over switch. (See Paragraph 2.11).

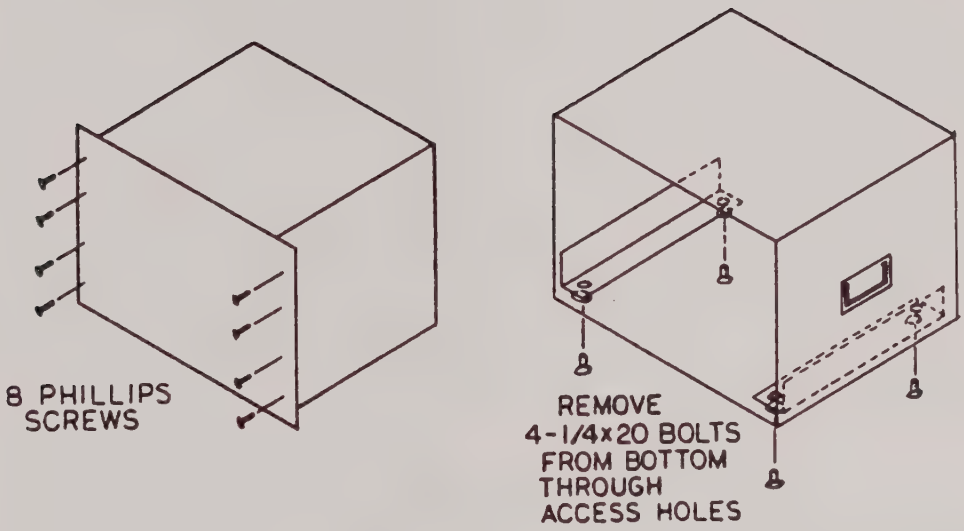
2.32 Rack Mounting (See Figure 2.31).

The Model 705C is installed in a cabinet which provides protection to the instrument during shipment. If the unit is to be rack mounted, the cabinet is removed as follows:

> Remove the four large shipping screws from the bottom of the unit through the access holes provided. Remove the eight large phillips screws at front panel left and right sides. The unit may now be slid out from the front. Since the unit is fairly heavy, rack mounted support rails must be provided to support the base plate.

CAUTION!

The RWO series BWOs employ a permanent magnet to focus the electron beam. Avoid any mechanical shocks to the tube while mounting. Also avoid any pressure to the output waveguide flange and power cable at the rear. The tube should only be lifted and carried by the main body.



NOTE: WHEN RACK MOUNTING SUPPORT RAILS MUST BE USED.

Figure 2.31

CABINET REMOVAL

2.33 Turn On Procedure.

Preset switches and controls as follows:

MAIN POWER	-	OFF	SWEEP RATE RANGE	-	M SEC.
H. V.	-	OFF	SWEEP RATE VERNIER	-	MAX C.W.
G2	-	OFF	TRIGGER MODE	-	AUTO
CW SOURCE	-	F1	MODULATION	-	OFF
MODE	-	CW	MARKERS	-	OFF
LEVELER	-	OFF			

At the BWO, connect waveguide hardware as needed to monitor RF power output, and provide a means of attenuating RF power to devices under test. Do not operate the BWO with an open waveguide flange as power levels in excess of the recommended 1 mW per square centimeter exposure are present. At no time should operating personnel connect or disconnect waveguide plumbing with the BWO operating.

CAUTION! DO NOT exert pressure on the BWO output flange. All waveguide components should be supported by the use of laboratory jacks or waveguide stands, so that there is no pressure exerted on the BWO flange. Also, there should not be any strong magnetic field placed near the BWO output flange to prevent distortion of the BWO's permanent magnetic field, which could affect RF operation.

2.33.1 BWO Heater Adjustment.

NOTE: BWO HEATER ADJUSTMENT IS NOT REQUIRED WITH MODEL 735, 736 OR 737 BWO HEADS.

Connect an ac voltmeter to the rear panel heater test points. **CAUTION! These jacks are directly connected to the Cathode H.V. power supply. Voltages up to 3000 volts may be present, therefore, the voltmeter must be capable of floating at this potential.** Set the voltmeter range to read 6.3 V ac.

With the controls preset as shown, turn main power on. The ac voltmeter should display about 4.0 V and start to rise slowly. At this time note the following: That the main power lamp is on, that all the digital displays illuminate, and that the 705C blowers and the BWO blower are running. Note also that the thermo/interlock indicator is not flashing.

As the heater voltage rises, it should be kept well below 6.3 V by adjustment of the heater adjust pot on the rear panel. Allow two minutes for final adjustment (6.3 V ac).

2.33.1 BWO Heater Adjustment (Cont'd).

During this time the H.V. Standby LED will illuminate. After the heater voltage stabilizes, remove the meter from the heater test points and then set the power supply controls as shown in the following table.

Set Grid 1 Vernier to maximum clockwise.
Set Grid 2 Coarse to the range that includes the G2 voltage advised by the data sheet for the tube in use.
Set Grid 2 Fine to maximum C.C.W.
Set Grid 3 Vernier to mid-range.
Check: Grid 2 H.V. switch is OFF.

2.33.2 CW Operation.

Confirm that the controls are set as in Section 2.33 and 2.33.1.
Confirm also that the high voltage ON/STANDBY LED is green.
Set the F1 control to its minimum value, fully counter-clockwise.

Set the H.V. switch to ON.
Check: H.V. LED is Red, G2 LED is Green.
Using the Meter Selector Switch, check:

G1 about 325 volts
G2 is 0 volts
G3 is 300 volts
Cath I is 0 mA.
Cath V is set to minimum for the cathode range in effect.

Now set G1 to data sheet CW recommended voltage.
Set G3 to data sheet CW recommended voltage.

Set Meter Selector Switch to monitor G2. Turn G2 ON.
Check: G2 LED is Red. Meter reading corresponds to G2 Coarse setting.

Set Meter Selector Switch to monitor Cath. I.
Check: Cathode current less than 10 mA.

With a suitable power meter or crystal detector connected to the BWO waveguide, monitor the RF output of the tube while closely watching the tube's Cathode current. Set G2 to the data sheet recommended voltage. Then trim the G1, G2 and G3 controls to produce maximum RF power output and minimum detected RF noise. The operator may have to change these settings as the tube heats up, but they will stabilize after about 15 minutes of operation.

If the BWO is to be used after a short "down" period, the system may be set to standby by switching G2 to standby and H.V. to standby.

To turn off the 705C, set G2 to standby, set H.V. to standby, and then turn main power off.

2.33.3 Swept Operation.

In the broadband sweep mode of operation, the frequency can be swept over all or any portion of the frequency range of the BWO tube as determined by the selected start (F1) and stop (F2) frequency points. The sweep is always made in the direction of increasing frequency and is performed in a constant time as determined by the Sweep Rate Range and Sweep Rate Vernier control setting.

During the forward sweep, an auxiliary sweep output voltage varying from 0 to +10V is available at the Sweep Output connector on the unit's front panel. This signal may be used to drive the horizontal axis of an oscilloscope or chart recorder. The sweep can be triggered by several alternative means, and an auxiliary blanking signal is available. Various marker and modulating options are also provided. A pen lift relay is included. The sweep LED glows for the duration of each forward sweep.

For broadband sweep operation, turn the instrument on as described for CW operation and make control settings as follows:

MODE	SWEEP
F1	DESIRED START
F2	DESIRED STOP
SWEEP RATE RANGE	AS DESIRED
SWEEP RATE VERNIER	AS DESIRED
MARKERS	AS DESIRED
MODULATION	AS DESIRED
TRIGGER MODE	AS DESIRED

The special position of the SWEEP RATE RANGE switch causes the unit to sweep upward from F1 to F2 in 25 milliseconds, the minimum time possible under microprocessor control.

2.33.4 Narrow Band Symmetrical Sweep (Delta-F Mode).

In this mode, a center frequency can be set anywhere in the band. The RF is swept symmetrically about this point with a maximum sweep range of +/- 12.5% of the full frequency range. The center frequency can be moved during operation, to allow quick adjustment of the area being examined. The width of the sweep is set by the F2 control and is displayed on the F2 display. The markers remain calibrated as they are in broadband sweep. The Sweep Output is 0 to 10 V but the waveform is different from that used in broadband sweep. All trigger and sweep modes are available. The sweep light glows during each forward sweep.

NOTE: In Delta-F Mode, it is possible to oversweep the ends of the BWO's frequency range. This will occur if the center frequency is set near the top or bottom of the tube's frequency range, and the sweep width is wider than the available margin of sweep.

2.33.4 Narrow Band Symmetrical Sweep (Cont'd)

For narrow band sweep operation, turn the instrument on as described for CW operation and make control settings as follows:

MODE	DELTA-F
CW SOURCE	F1
F1 VERNIER	OTHER THAN MINIMUM
TRIGGER MODE	AUTO
MARKERS	OFF
OTHER CONTROL SETTINGS	AS DESIRED

2.33.5 Special Sweep Rate Mode.

The Special Sweep Rate mode is intended to sweep the BWO's Cathode to Helix voltage, and therefore its output frequency, at the microprocessor's maximum rate, and to retrace the tube as rapidly as possible. This will typically cause some loss of sweep linearity due to hysteresis effects in the tube and power supply.

This mode is intended for flicker-free displays of sweep versus power or VSWR on an oscilloscope.

2.33.6 RF Output Modulation.

The RF output can be either amplitude modulated (using an external signal or the internal square wave) or frequency modulated (using external signals). Modulation of either type can be used in CW and swept modes of operation. The front panel Modulation Switch allows selection of either internal (SQ. WAVE) or external (EXT) amplitude modulation (ON-OFF type only), or no amplitude modulation at all. Frequency modulation can be obtained by applying a suitable signal to the rear panel FM input connector.

Internal square wave modulation is convenient for use with measurement systems that have an audio-frequency measurement circuit. 100% modulation may be obtained with most BWOs by careful tuning of the tube's grid voltages. Special instructions for square wave modulation may be included with the tube's data sheet. The standard frequency for most systems is nominally 1 kHz. The Frequency Vernier control permits setting the modulation frequency from about 600 Hz to 3 kHz.

External amplitude modulation extends the versatility of the instrument. This input operates from digital circuits and uses TTL type elements. A logic 1, about +5 V, applied to this input turns the BWO tube on. This modulation is of the ON-OFF type.

Frequency modulation is always available through the FM input connector. This input is a vernier frequency control with a sensitivity of 5 volts for 10% of the bandwidth of the BWO tube in use.

2.33.7 Leveling Operation.

Proper leveling operation is entirely dependent on the external waveguide components employed. These waveguide components must not exhibit frequency selectivity over the desired leveled band, as this selectivity will introduce power variations during leveled operation. Also required, is a diode detector that provides at least 50 mV into 2000 ohms at the minimum power point of the region to be leveled.

DC signals, from the sampling diode detector, are fed into the 705C's Level In connector. These signals are applied to the Sensitivity control. The rotor of this control is fed to the input of a differential amplifier, where this dc level is compared to an adjustable dc reference. The dc reference level is controlled from the front panel POWER control. The error signal obtained from the differential amplifier is amplified and fed to an opto-isolator, where transformation from ground referenced levels to high voltage Grid 1 modulation is accomplished. Other amplitude modulating signals are added to the leveler signal at the opto-isolator input.

The leveling control system may be adjusted in this manner: Set the 705C for Auto Sweep, F1 to F2, over the desired frequency range; connect the Sweep Output to an oscilloscope's external sweep input, connect the RF power sampling diode to the scope's vertical input and set the scope for X-Y display. Terminate the sampling diode with a 2000 ohm resistor.

Adjust grid voltages, G1, G2 and G3 for peak detected dc response and minimum noise.

Check that the diode output is at least 50 mV at the lowest power point to be leveled.

Check that crystal Polarity switch corresponds to the polarity of the diode detector voltage.

Connection of the crystal output to the Leveler input connector will allow the BWO output power to be controlled automatically. (Remove the 2000 ohm termination).

Turn the Power control fully clockwise and adjust the sensitivity control so no leveling occurs. Turn the power control counter-clockwise, but not off. The BWO power should now be leveled. The Minimum power control sets the lower level of power, which should be set about 6 dB below the minimum BWO power output when unleveled.

2.33.8 BWO Operation After Long Idle Periods.

If the BWO tube has not been operated for several weeks, it is advised that the turn on procedure be followed exactly. The shorter wavelength BWOs, RWO110 and RWO170, may not generate RF power until they have been on for several minutes, and their operating conditions may change rapidly until the tube has regained its original stability. To help "burn-in" these tubes, operate them at the low end of their frequency range for several hours, using the G1 control to keep the cathode current below the data sheet specification.

2.4 GPIB (IEEE-488) Interface Operation.

The GPIB interface may be used to control the output frequency of the unit, via the internal microprocessor and the frequency control DAC, and it may be used to trigger a sweep from F1 to F2 as determined by the settings of the front panel controls.

The following discussion of the GPIB interface assumes a familiarity with the IEEE Standard 488-1978 and with parallel I/O and microcomputer programming in general.

The GPIB address switches are located on the rear of the unit below the GPIB connector. There are seven switches, but only the five rightmost are used to set addresses for the interface. **When depressed "on" the bit is true. The two leftmost switches must always be depressed "off" or false, for proper operation.** The program illustration used in this manual assumes the 705C is at address 3.

2.41 Setting the Output Frequency Via the Bus.

The 705C's output frequency may be set remotely via the GPIB. Operation in this mode is analogous to CW mode, except that the Mode switch is set to Remote and the Sweep Trigger Mode is set to Manual.

There are several sources of frequency error in the remote operation of the 705C. The frequency calibration is determined by a least squares curve fitting algorithm which is factory calibrated to fit the BWO's voltage to frequency characteristics within 1%. In remote mode a different signal path is selected inside the 705C than the path for which the unit was calibrated. The different signal path may randomly improve or degrade the unit's frequency calibration, but by not more than an additional 1%. Users who require a tighter frequency calibration may wish to create a frequency look-up table by comparing the set frequency, via the BUS, to the actual frequency output of the BWO, and then use this look-up table to set the output frequency of the tube.

THE F COMMAND

The F command may by used to set the output frequency of the BWO in 100 MHz steps between the tube's minimum and maximum programmed operating frequencies. These minimum and maximum frequencies may be read from the front panel displays by setting the F1 control to its minimum and the F2 control to its maximum reading and recording the digital displays.

The F command has the syntax of the letter F, a space, and four decimal numbers, including leading zeros as required. The least significant number represents units of 100 MHz. You may test the F command by using the simple test program, PROG85, with an HP85.

THE B COMMAND

The B command gives the operator direct access to the frequency control DAC through the GPIB. The number input to the BUS is converted to a binary number and transferred to the frequency control DAC. Decimal numbers 0000 through 4095 will proportionately set the BWO's output frequency across its available band width.

The B command has the syntax of the letter B, a space, and four decimal numbers, including leading zeros as required. You may test the B command by using the simple test program, PROG85, with an HP85.

THE O COMMAND

The O command will turn the RF power off from the BWO via G1 without changing the BWO frequency. To turn the RF power back on, use an F or B command that repeats the desired frequency or sets a new frequency.

The O command has the syntax of the letter O. You may test the O command using PROG85 as descibed in the previous paragraphs.

THE T COMMAND

The T command triggers the front panel sweep according to the settings of the F1, F2, and Sweep Rate controls. After the T command is executed there is a short delay before sweep begins, while the internal microprocessor recovers the control settings and switches to sweep mode.

The T command has the syntax of the letter T. You may test the T command using PROG85 as described in following paragraphs.

2.42 Test Programs.

Three short test programs are included:

PROG85 permits direct execution of the F, B, O, and T commands.
PROG87 is a sweep loop from F1 to F2.
PROG88 is a binary sweep loop for the full bandwidth of the tube.

All three programs were written for the HP85.

```
 10 REM *** PROG85
 20 REM *** SHORT PROGRAM TO PLA
    Y WITH 705C BUS
 30 REM *** WAYNE R. OPENLANDER
 40 REM *** NOVEMBER 7, 1985
 50 INPUT A$
 60 OUTPUT 703 ;A$
 70 S=SPOLL(703)
 80 DISP S
 90 GOTO 50
100 ! F COMMAND SETS OUTPUT
110 ! FREQUENCY IN 100 MHZ
120 ! STEPS BETWEEN TUBE'S
130 ! START AND STOP FREQUENCY
140 !
150 ! B COMMAND SETS THE CONTROL
160 ! DAC TO A 12 BIT BINARY
170 ! NUMBER FROM INPUT DECIMAL
180 ! NUMBER.
190 !
200 ! T TRIGGERS FRONT PANEL
210 ! SWEEP.
220 !
230 ! O TURNS TUBE OFF
235 !
240 ! SEND "F DDDD"
250 ! SEND "B NNNN"
260 ! SEND "T"
270 ! SEND "O"
```

```
100 REM PROG87
102 REM PSEUDO SWEEP FOR 705C
104 REM WAYNE R. OPENLANDER
106 REM MICRO NOW INSTRUMENT
108 REM NOVEMBER 11, 1985
110 REM F1 TO F2 SWEEP
120 REM GET START FREQUENCY
130 DISP "ENTER START FREQUENCY"
140 INPUT F1
150 DISP "ENTER STOP FREQUENCY"
160 INPUT F2
170 REM RUN THE SWEEP LOOP
180 IMAGE "F " 4Z
190 FOR N=F1 TO F2 STEP 1
200 OUTPUT 703 USING 180 ; N
210 NEXT N
220 OUTPUT 703 USING 180 ; F1
230 END
```

```
100 REM PROG88
102 REM PSEUDO SWEEP FOR 705C
104 REM WAYNE R. OPENLANDER
106 REM MICRO NOW INSTRUMENT
108 REM NOVEMBER 11, 1985
110 REM BINARY SWEEP
170 REM RUN THE SWEEP LOOP
180 IMAGE "B " 4Z
190 FOR N=0 TO 4095
200 OUTPUT 703 USING 180 ; N
210 NEXT N
220 OUTPUT 703 USING 180 ; 0
230 END
```

2.5 System Operation With External Equipment.

The Model 705C will often be used in conjunction with various measuring and recording instruments to test waveguides, detectors, attenuators, or reflection coefficient of various kinds of microwave hardware. The instruction manual of the accessory instrument will adequately cover the interface levels it requires. The use of the Model 705C with some of the more common types of readout instruments will be covered briefly in the following sections.

2.51 Oscilloscope Display.

The Model 705C has several provisions for oscilloscope display of the RF output. The Sweep output connector provides a constant amplitude ramp voltage that can be used to drive the X axis or horizontal amplifier of an oscilloscope, while the Y axis (or vertical amplifier) is driven from the RF detector. In the Milliseconds Sweep Range, a sweep display that is sufficiently flicker free for most tuning purposes can be obtained with the rate control set to fully clockwise. The user may also wish to experiment with the Special setting of the Range Switch.

The Blanking output from the 705C may be used to modulate the Z-axis of an oscilloscope, to reduce the intensity of the dot that appears on the oscilloscope tube during retrace.

2.51 Oscilloscope Display (Cont'd).

The Model 705C can be operated from an external sweep source such as the sawtooth output of an external test oscilloscope. Two methods can be used for this function.

METHOD 1. A dc control voltage from 0 to +5 volts, operating into 10 kohms will drive the cathode supply over the full range set by the frequency programmed EPROM. The test set-up is as follows:

A voltage divider is installed on the test oscilloscope's sweep output connector to provide 0 to +5 volts. For example, if the oscilloscope provides a sawtooth from 0 to +150 volts, a divider which gives a 30:1 ratio would produce the desired results. The output of the divider is fed by coaxial cable to the Model 705C External sweep input BNC. (See Fig. 2.5A below). The 705C function switches are set for external sweep, CW, and F1 set to minimum operating frequency.

METHOD 2. The same set-up as above is used, except that the required input voltage is 0 to +50 volts. This then requires a divider to give a 3:1 ratio for a +150 volt sawtooth signal. (See Fig. 2.5B below). In this case, the 705C function switches are set for EXT. FM input, and F1 set to minimum operating frequency. The test signal is fed into the EXT. FM input BNC.

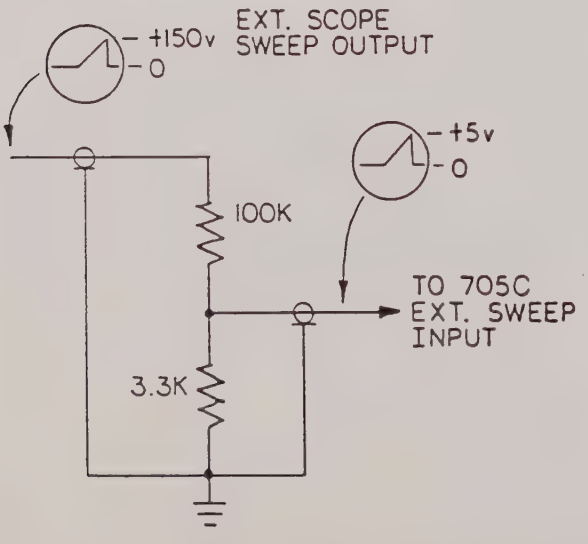


FIGURE 2.5A

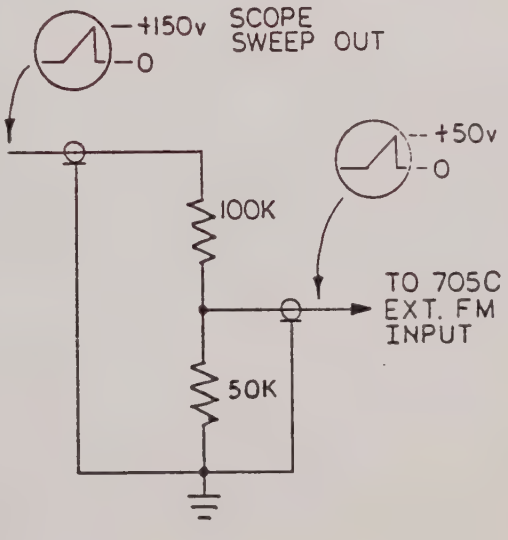


FIGURE 2.5B

2.52 X-Y Recorder Display.

The Model 705C has several provisions for connection to an X-Y recorder. A Proportional Sweep output connector provides an output voltage that is proportional to the output frequency on a percent of the tube bandwidth basis, with 5 volts equal to the full band. When this output is connected to the X axis of an X-Y recorder, the frequency scale may be directly calibrated in GHz per inch or centimeter, by selecting the appropriate gains and scaling factors.

The front panel Sweep Output is a 0 to +10 volt signal that may also be connected to the X axis of an X-Y recorder, and the Manual Sweep control may be used in CW mode to set and review the gain setting of the recorder.

A mechanical pen lift relay may be controlled from the Blanking Relay contact terminals and a single forward trace may be initiated with the Manual Trigger Switch.

2.53 Power Meter Display.

The Model 705C has features which complement its usage with a direct reading power meter. In the slowest Seconds Rate setting the 705C will sweep slowly enough to allow the measurement time constant to settle, for many such instruments. The F1 display is updated in 100 MHz increments, so that the operator may observe the frequency while measurements are being made.

2.54 Scalar Network Analyzers.

The Model 705C has been designed to operate will all popular scalar network analyzers that use dc signals from the power detector diodes. A 2 ms delay during frequency retrace is provided in Milliseconds and Seconds Sweep Modes to allow the scalar analyzer to auto zero. Both Micro-Now and the manufacturer of the analyzer may have special information about interconnecting the sweeper, measurement bridge, and the analyzer. If problems are encountered in operation, please contact both of them.

2.55 Millimeter Wave Frequency Counters.

A source locking frequency counter is now available. This counter has been used to measure and lock the frequency output of the Model 705C. Careful adjustment of the BWO tube's operating voltages, especially G3, is important. These voltages are adjusted by trial and error for minimum FM and residual FM in the RF output; fortunately this minimum occurs near the BWO tube's maximum power output. Frequency lock may be obtained by connecting the phase error output of the counter directly to the FM Input of the 705C, or if improved lock bandwidth is desired, the source locking counter may be connected to the 705C through a Micro-Now Model 212 BWO Lock Adapter.

2.56 Frequency Stabilization.

The Model 705C has several provisions which allow frequency stabilizing techniques to be employed. Micro-Now manufactures several types of stabilizers which have successfully locked the RWO series of Backward Wave Oscillators up to 170 GHz. The Models 211 and 215 systems in particular have been used to provide stable CW frequency control, and are capable of reducing the phase noise of BWOs to under 1 kHz at 100 GHz. Section 3.3 of this manual contains an in-depth discussion of stabilization techniques and applications.

SECTION 3 ANCILLARY EQUIPMENT

3.0 ANCILLARY EQUIPMENT:

3.1 Siemens Corp. Backward Wave Oscillator Tubes.

3.2 Varian Corp. Backward Wave Oscillator Tubes.

3.3 Frequency Stabilization.

- 3.31 Practical Techniques.
- 3.32 Connecting the Stabilizer.
- 3.33 BWO Tuning.

3.4 Pulse Modulation.

- 3.41 External AM Input Pulsing.
- 3.42 Grid 1 Pulsing at BWO Head.
- 3.43 Pin Diode Modulation.

3.5 Leveling Hardware Requirements.

3.0 ANCILLARY EQUIPMENT:

3.1 Siemens Corp. Backward Wave Oscillator Tubes.

The Model 705C is primarily intended for use with Siemens Corp. backward wave oscillator tubes. Siemens Corp. manufactures these BWO tubes to cover the frequency range of 25 to 170 GHz in waveguide band steps. A Cathode to Helix voltage tuning curve is supplied with each tube. This curve shows the operating frequency and power output as a function of the Cathode to Helix voltage, and the nominal operating values for the Grid 1, Grid 2, and Grid 3 voltages.

Typical operating voltages for these BWO tubes, as determined by the experience of Micro-Now Instrument Co., Inc. are (except RWO 35):

G1	-250 +/-50 V
G2	2200 +/-700 V
G3	260 +/-60 V
V (C-H)	-550 to -2650 V or -600 to -3000 V
I Helix	13 +/-2 mA
V Heater	6.3 V ac
I Heater	1 A

The following operating sequence conforms with that required by Siemens Corp. for their BWO tubes.

STARTING

1. Switch in air cooling; switch on heater voltage and preheat the tube.

2. Simultaneously apply the Cathode to Helix, G1 and G3 voltages.

3. Adjust the G1 and G3 voltages according to the tuning curve supplied with the tube.

4. Set the G2 voltage for the operational value and switch it on.

5. Adjust the tube to the required frequency by setting the Cathode to Helix voltage as required.

6. Adjust G3 voltage for optimum power.

3.1 Siemens Corp. Backward Wave Oscillator Tubes (Cont'd).

SWITCHING OFF

On no account switch the Helix voltage or G3 voltage off first as the tube can be damaged.

1. Switch off G2 voltage.

2. Switch off remaining supply voltages.

If a tube has not been operated for a length of time (each tube has a unique personality in this respect, and experience is the best guide) it may not operate when it is brought back into service. Voltages and currents will measure correctly but there will be no output power, or the power will be very weak. It is advised that the tube be preheated for about 15 minutes, and then operated for about one hour with normal electrode but a reduced Cathode to Helix voltage of 600 to 800 volts.

If an unused tube triggers an overload when it is brought back into operation, try operating it with the G2 voltage reduced about 500 volts below that specified on the data sheet.

3.2 Varian Corp. Backward Wave Oscillator Tubes.

BWO Heads that use Varian Corp. BWOs include a dc heater voltage, a fixed anode voltage, and a grid voltage power supply to provide the special voltages that these tubes require. As a result, operation with the 705C is different with these tubes than with Siemens tubes.

No G2 voltage is required, do not turn G2 on.

A lower Cathode to Helix voltage range is required, set the range on the 705C to range 1.

The ac heater voltage adjustment on the back of the 705C has no effect on the heater voltage of the Varian BWO; do not adjust it.

Set the G1 and G3 voltages as specified by Micro-Now for operation with the Varian tube; the voltages displayed on the 705C's meter are modified by circuits inside the housing before they are connected to the Varian BWO. The G3 supply is used for the anode of the Varian tube, and is regulated to a lower voltage by a circuit inside the BWO Head. The G1 supply is used for the control grid of the Varian tube, and is dropped to a lower value by zener diodes inside the BWO Head.

Refer to Model 735-736 Manual sent with the Varian BWO for further details.

3.3 Frequency Stabilization.

Various techniques are available to reduce or eliminate the frequency drift and improve the phase noise of backward wave oscillator tubes. These techniques, in general, transfer the stability of a microwave reference generator to the millimeter-wave signal. The millimeter-wave signal, and a harmonic of the microwave signal, are mixed together, and the resulting IF signal is processed to develop an error voltage. The error voltage is fed back to a tuning element of the BWO tube in such a way that it corrects for the deviation in frequency.

Frequency correction of the BWO tube may be done by varying any of the grid or anode voltages, or by modulating the tube's Cathode to Helix voltage. Satisfactory frequency stabilization may usually be obtained by connecting the error signal to the FM input of the 705C, this will modulate the BWO tube's Cathode to Helix voltage through an amplifier of very limited bandwidth.

Phase stabilization requires that the phase error signal be directly connected to a tuning element of the BWO tube. Considerable experimentation has been performed and the results are summarized in the table that follows:

Cathode-Helix Control: Tuning sensitivity may be calculated from the tube data provided my the manufacturer. Draw a line tangent to the stabilized frequency on the manufacturers tube curve and calculate the slope of this line. The stabilization voltage may be inserted into the Helix to ground circuit by insulating the BWO housing and flange from ground, and connecting the stabilization voltage between the housing and ground. Most Micro-Now BWO Heads include this feature, and instructions are included with the Head.

Grid 1: The tuning sensitivity of G1 is unpredictable, but is a fraction of the Cathode to Helix control voltage tuning sensitivity. Stabilization through G1 will also modulate the power output of the tube because G1 controls the tube's power output.

Grid 2: BWOs that have a G2 may be stabilized in much the same fashion as a reflex klystron is stabilized through its reflector. The stabilization signal may be connected in series with the G2 voltage through the stabilization connector on the rear of the 705C. The tuning sensitivity of G2 is a small fraction of the tuning sensitivity of Cathode to Helix control voltage, on the order of several hundred kHz/V. It may be measured by changing the G2 voltage on the tube, and measuring the change in output frequency.

Grid 3: The frequency output of a Siemens BWO will increase when the G3 voltage is varied to either side of its optimum value. G3 stabilization therefore requires that the BWO tube be intentionally operated with G3 set to a compromise value; it is not recommended.

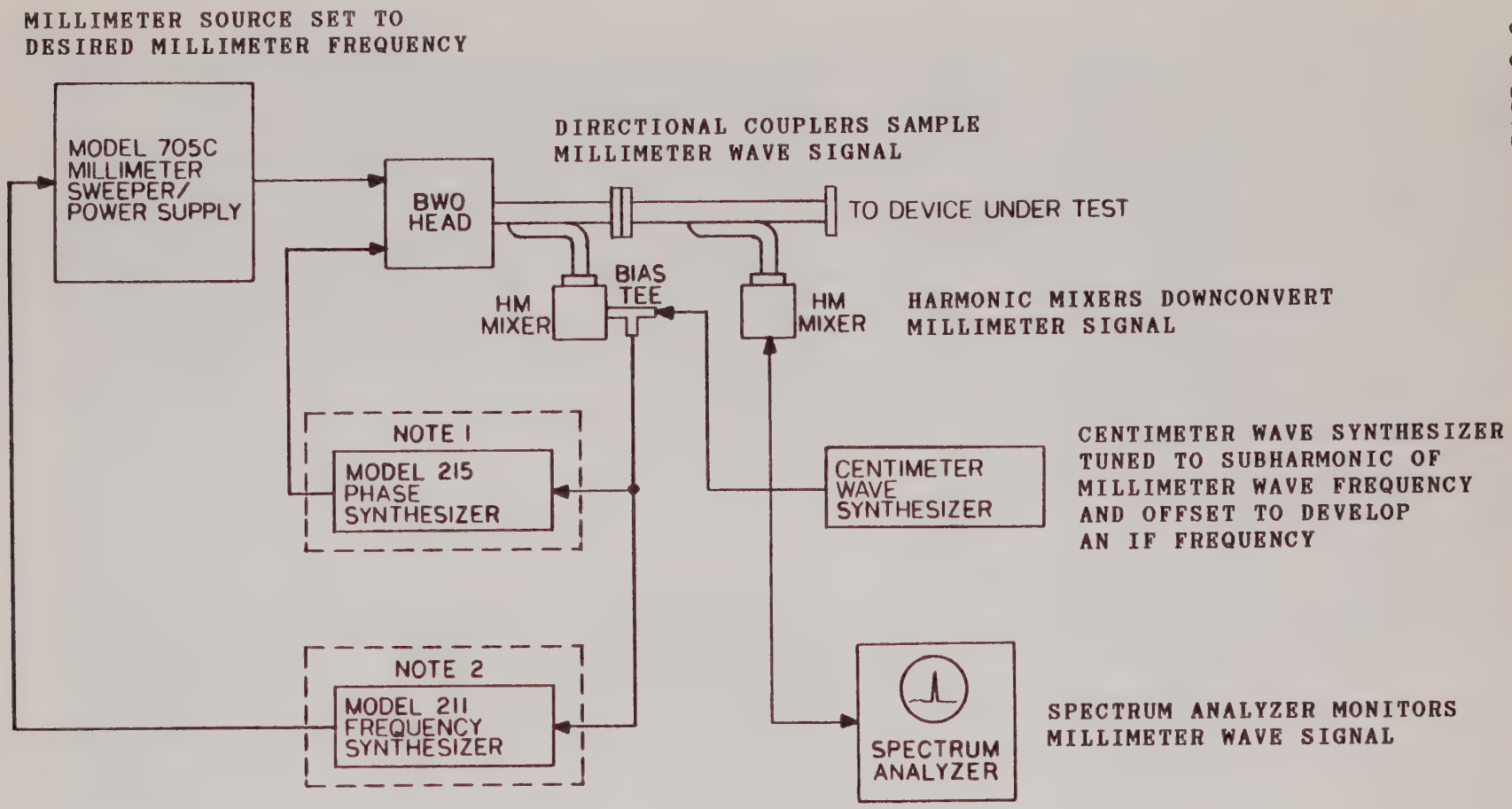
3.31 Practical Techniques.

Siemens millimeter-wave BWOs may be stabilized in a manner similar to a reflex klystron by connecting the error signal in series with the G2 voltage on the tube. A rear panel connector, J1, is provided for this purpose. The tuning sensitivity of the tube must first be measured, and the stabilizer's lag network adjusted accordingly. Different operating frequencies will probably require different lag networks.

All BWO tubes may be stabilized by connecting the error signal between the tube's Helix and circuit ground. A connector for this purpose is provided on the rear of the Micro-Now's BWO head, or with the connector installation kit.

In some circumstances, stabilization with source locking counters, for example, a compound between G2 modulation and direct Helix connection will be desired. Micro-Now offers a Model 212 Lock Adapter which permits the lock signal to be connected to the 705C through the FM input and G2, and thus avoid the special precautions that direct Helix connection required.

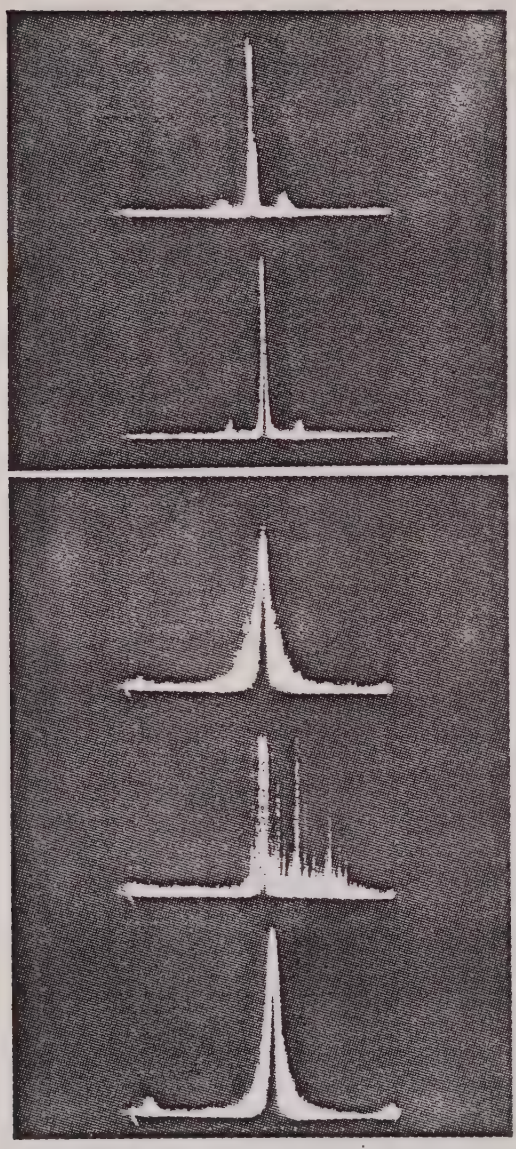
Figure 3.3 illustrates a typical stabilization setup. The microwave reference signal is applied to the harmonic mixer through a signal diplexer. The millimeter-wave signal is sampled by a directional coupler and also applied to the harmonic mixer. This downconverts the millimeter-wave signal to an IF frequency. The IF signal is amplified and compared to a second reference signal inside the stabilizer. The processed error signal is then connected back to the BWO tube. Typical results of stabilization tests are summarized in Figure 3.3A with oscilloscope photos.



NOTE 1: MODEL 215 USES 750 MHz IF AND STABILIZES THROUGH THE BWO HELIX TO GROUND.

NOTE 2: MODEL 211 USES 30 MHz IF AND STABILIZES THROUGH G2.

MILLIMETER WAVE STABILIZATION EXAMPLE
FIGURE 3.3



(1) Unstabilized.

(2) G1 Stabilized.

(3) G3 Stabilized.

(4) Unstabilized.

(5) G3 Stabilized

Figure 3.3A

The above photos show the results of stabilization on a RWO 60 BWO operating at 45 GHz. The spectrum analyzer was operated in the linear display mode. Photos 1 and 2 show the effect of stabilizing Grid 1. Horizontal display was 1 MHz/cm. Photos 3, 4, and 5 show Grid 3 stabilization. In these photos the horizontal display was expanded to 300 kHz/cm.

Results: Unstabilized, the long-term frequency drift was about +/- 2 MHz, and the phase noise was about 1 MHz wide, 20 dB down from peak output.

Stabilized, both G1 and G3 reduced long-term drift to less than 1 MHz. Phase noise reduction was about 500 kHz with G1 and about 100 kHz with G3.

3.32 Connecting the Stabilizer.

A klystron style stabilizing system must be capable of supplying error correction voltages which are isolated from chassis ground by at least 3000 volts when stabilization is applied to any of the BWO grids, since these grids are referenced to the Cathode high voltage supply.

The G2 stabilizer jack, a 3-pin high voltage connector, is shipped with a dummy plug inserted which shorts out an internal 470 kohm resistor that is in series with the G2 output voltage to the RWO power plug. The pin arrangement is as follows; (A) to BWO EG2 (stabilizer error voltage input), (B) chassis ground, and (C) from EG2 power supply (stabilizer HV return).

If stabilization is to be applied to the Cathode return line (Helix connection), the stabilizer will be operating slightly off ground, within +/- 10 volts, but must provide a low impedance to the Cathode current. Current drive capability should be at least 20 milliamperes.

3.33 BWO Tuning.

A Siemens RWO type BWO, when powered by a well regulated power supply such as the Micro-Now Model 705C, exhibits short term frequency drift. This drift varies from about +/- 2 MHz at 40 to 50 GHz to about +/-5 MHz at 140 GHz. It is therefore a requirement that the frequency stabilizer being employed have as large a capture range as possible for ease of initial locking. The BWO should be set to a CW operating mode and have been running for at least 45 minutes before attempting to stabilize. This allows the tube structure to reach thermal equilibrium. The following power supply adjustments should be made:

(a) Cathode Helix supply - set for desired BWO output frequency.

(b) G1 - set so that minor changes in G1 voltage do not produce a change in RF operating frequency.

(c) G3 - "Peaked" to produce maximum RF power output, minimum detected RF noise, and as above - set so minor changes in G3 do not cause frequency change.

(d) G2 - for stabilization, G2 should be set below the "peak", which is similar to G3 operation above. Correct setting of G2 will allow about a +/-15 volt change to be made which causes a linear shift in RF frequency, without introducing excess RF noise or RF power variation. Otherwise set per data sheet.

The criteria to use for tuning setup is that error correcting voltage allows change of RF frequency with no introduction of excessive noise or AM products.

3.4 Pulse Modulation.

There are three methods which may be used to produce pulse modulation with the Siemens RWO series of Backward Wave Oscillators. These are (a) Externally Pulse Modulating using the Model 705C EXT. AM input connector, (b) Grid 1 Pulsing at the BWO Head, and (c) PIN Diode Modulation.

3.41 External AM Input Pulsing.

A positive going pulse of 5 volt amplitude at the External AM Input BNC will produce on/off modulation of a 50 usec. rise time and a 30 usec. fall time. This connector may be used to couple in external reference square waves up to 10 kHz.

3.42 Grid 1 Pulsing at BWO Head.

Fast pulse response of approximately 15 nanoseconds rise and fall times can be accomplished by a special modification to the BWO Tuning Head, and using an external Pulse Generator.

The external pulse generator must be capable of producing a positive-going pulse of 100 volt amplitude into a 50 ohm load. Typical operation is as follows:

> Set the Model 705C system for normal operation at the frequency of interest. Tune G1, G2 and G3 for maximum detected RF output and minimum noise. Set G1 more negative until RF output is negligible (usually about 100 volts more negative than data sheet voltage). Now increase the external pulse generator output while monitoring the detected RF output of the BWO. As the pulse amplitude increases, trim Grid 3 for best pulse rise and fall times and minimum overshoot. Figure 3.4A shows the network to be installed in the BWO Head. Note that the circuit involves high voltage wiring and all precautions involving HV circuitry must be observed to avoid damage to the BWO or Grid 1 power supply. Figure 3.4B shows a block diagram of a typical test set-up using this method of Grid 1 pulsing.

3.43 PIN Diode Modulation.

PIN diode modulators may be employed to produce extremely fast rise and fall time pulses. However, they usually have finite on-off ratios of approximately 20 to 40 dB, so the RF signal is not completely off between pulses. At millimeter waves, the PIN diodes are also usually narrow band devices and may exhibit excessive insertion loss. One advantage of the PIN modulators is that the BWO can be operated in a CW position.

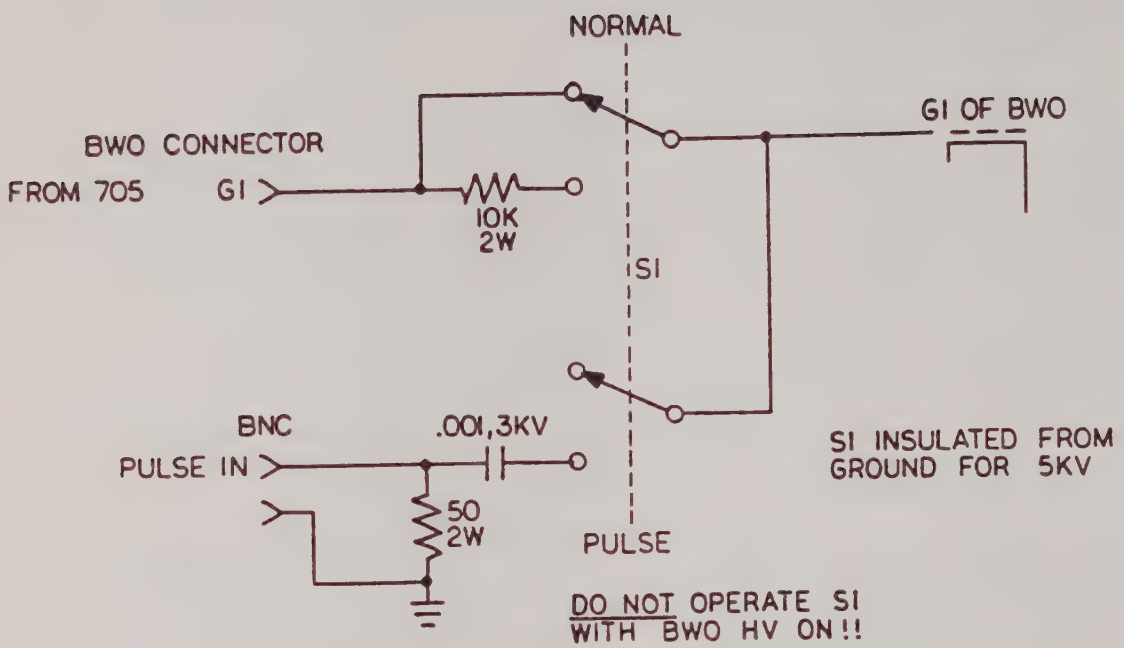
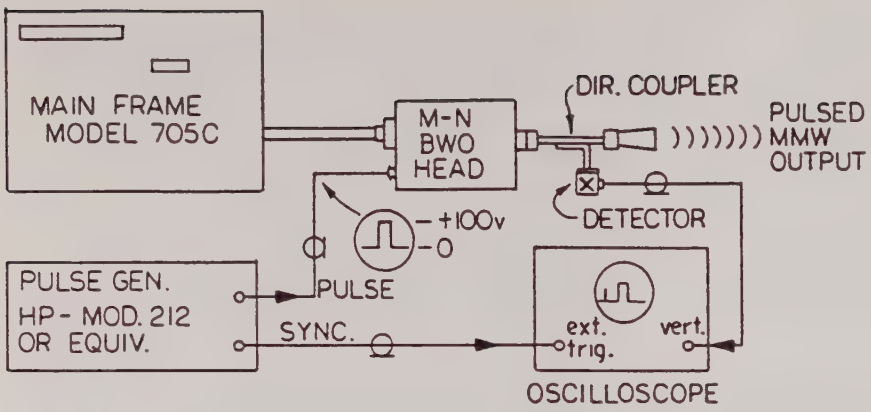
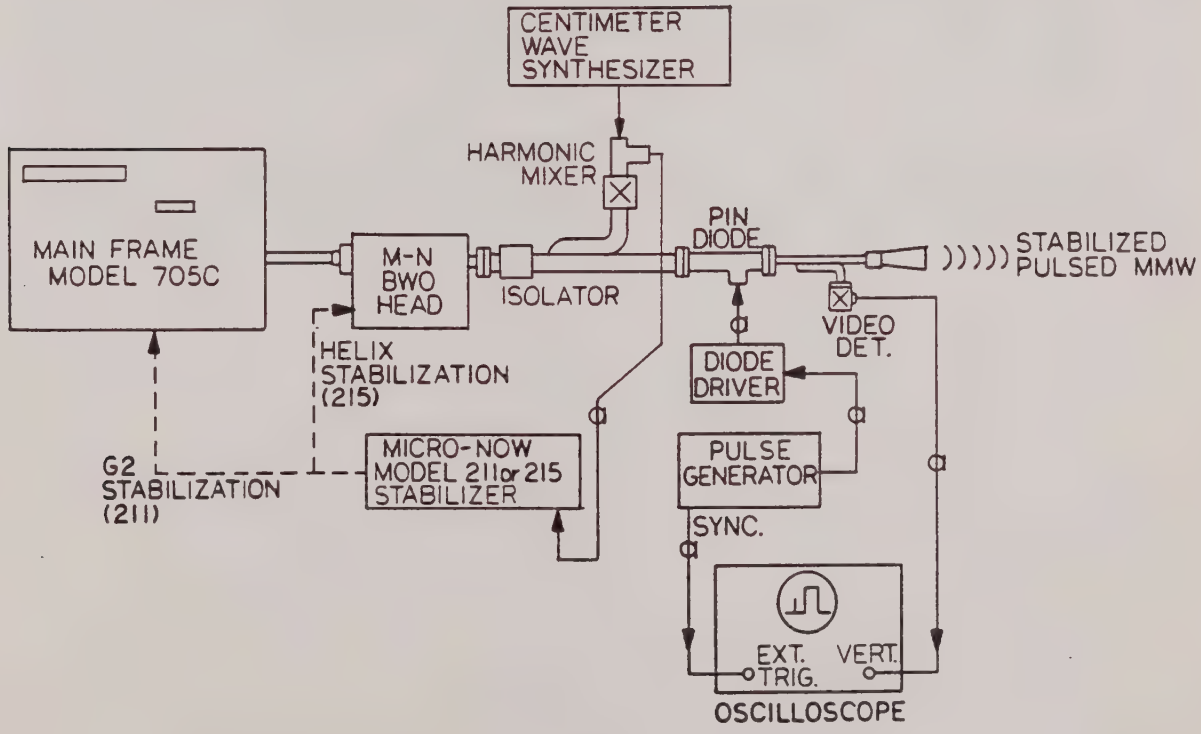

NORMAL
G1 OF BWO
BWO CONNECTOR
FROM 705
G1
10K
2W
S1
BNC
.001,3KV
PULSE IN
50
2W
PULSE
S1 INSULATED FROM
GROUND FOR 5KV
DO NOT OPERATE S1
WITH BWO HV ON!!

FIGURE 3.4A



GRID I PULSE TEST SETUP FIGURE 3.4 B



PIN DIODE PULSING WITH
BWO FREQUENCY STABILIZATION

FIGURE 3.4 C

3.43 PIN Diode Modulation (Cont'd).

This allows frequency stabilization techniques to be employed prior to PIN modulation, thus producing a millimeter wave pulsed signal of exceptional spectral purity. Figure 3.4C shows this type of set-up. Refer also to Section 3.3 of this manual for further discussion of Frequency Stabilization.

3.5 Leveling Hardware Requirements.

The directional coupler and diode mount necessary for BWO power leveling must be capable of the following:

a) Directional couplers must exhibit a constant insertion loss and output coupling loss over the frequency range to be leveled. The coupling loss should be consistent with the expected power levels from the BWO, such that diode detectors are presented with signal levels in their square law region.

b) Diode detectors must also be "flat" over the frequency range to be leveled. They must produce at least 50 millivolts detected dc into 2000 ohms at the minimum power point of the region to be leveled and be operated in the square law region - below saturation.

c) The combined effects of the coupler and detector as described above determine the over-all leveling performance. Typical responses for good broadband components can produce leveled power output which is flat within +/-2 dB over the full waveguide band.

SECTION 4 ADDITIONAL REFERENCE

4.0 ADDITIONAL REFERENCE:

4.1 Phase Lock Microwave Frequency Stabilizer - Model 211.

4.2 Lock Interface For MMW Oscillators - Model 212.

4.3 MMW Source Phase Synchronizers - Model 215.

4.4 BWO Tube Information.

Micro-Now Instruments

MODEL 211

Phase-Lock Microwave Frequency Stabilizer

- digital phase-frequency detector
- positive lock indicator
- high short term stability
- high sensitivity
- usable at any frequency

MODEL 211

Any voltage-controlled microwave oscillator can be stabilized to the same order of accuracy and stability as a low-frequency crystal oscillator with a Micro-Now Model 211. This is accomplished by using a Model 211 to phase lock the difference frequency between the microwave oscillator and a suitable harmonic of the external reference crystal oscillator to an internal crystal oscillator at the stabilizer's intermediate frequency.

The improved Model 211 exhibits greater stabilizing capability than previous stabilizers due to a recently developed digital phase-frequency detector, which provides a more reliable lock under a wider range of perturbations than is possible with a conventional diode phase detector. This is due to the positive pull-in characteristics of this type of detector and its four-fold increase in linear phase range. In addition to the digital phase-frequency detector, the Model 211 also includes a low noise IF amplifier, an internal high-stability 30 MHz reference crystal oscillator, a wideband amplifier/limiter, and the Lock Indicator circuit.

A reliable indication of proper phase lock operation is provided by the Lock Indicator circuit. The Lock Indicator consists of a very narrow crystal filter, tuned to the same frequency in the IF pass band as the internal crystal oscillator, and a front panel indicator light. The filter passes the difference signal only when it is within a few hundred Hertz of the frequency of the internal oscillator and well within the pull-in range of the stabilizer circuitry, driving the indicator light.

The Model 211 is designed to be used with any good quality harmonic generation system.

SYNCHRONIZING TWO OSCILLATORS:

In some applications absolute frequency stability is not necessary as long as the difference frequency between two microwave oscillators remains constant. A Micro-Now Model 211 Stabilizer may be used to lock one microwave oscillator to another, with a frequency offset of 30 MHz. The stabilizer then automatically tunes the first oscillator to track any frequency drift that occurs in the second.

MODELS:

The Model 211 A1 is for use with low current voltage-tuned microwave sources such as klystrons and/or varactor-tuned Gunn oscillators.

The Model 211 C1 is designed to be used with tubes such as backward wave oscillators and voltage tunable magnetrons, which require appreciable current on the tuning element. All specifications other than control signal output are identical to those of the Model 211 A1.

SPECIFICATIONS

Input Frequency ..... 30 MHz

Stability, Internal Oscillator

Long term (24 Hours) $1/10^6$

Short term (30 minutes) $1/10^7$

Short term (1 second) $1/10^8$

Sensitivity ..... – 60 dBm

Control Signal Output

Model 211 A1 ..... ±8V at 0.2 mA

Model 211 C1 ..... ±8V at 20 mA

Both insulated for 3000 VDC

Reference Signal ..... 30 MHz, crystal controlled or connection to an external source.

Phase Lock Indicator ..... Filter Bandwidth less than 200 Hz.

Metering ..... Phase error voltage: ±10V.

Limiter (Mixer) current: ±100 uA (±10 uA)

Power ..... 115 VAC, 50-60 Hz, ½ Amp.

Size W x H x D ..... 17 x 5 x 16 (inches)

43.2 x 12.7 x 40.6 (cm)

Weight ..... 11 lbs. (5 kg)

5/86

Micro-Now Instrument Co., Inc.

8260 North Elmwood Street, P.O. Box 1488, Skokie, Illinois 60076, (312) 677-4700

PRELIMINARY DATA SHEET

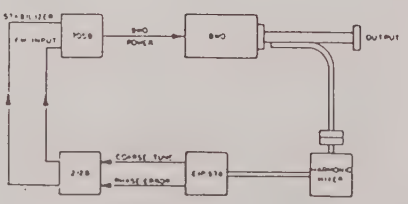
Model 212 Lock Interface
for Millimeter-Wave Oscillators

The Micro-Now Model 212 Lock Interface is a solid-state signal level translator that will translate the output of a ground-referenced phase/frequency stabilizer to the elevated voltage requirements of typical millimeter-wave oscillators. It is designed to be used with Backward Wave Oscillator (BWO) and klystron tubes, as well as with solid state sources such as varactor-tuned Gunn oscillators.

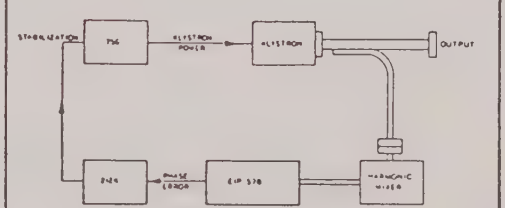
Three versions of the Model 212 are currently available, to accomodate the specific requirements of the various millimeter wave sources. The Model 212B is for BWOs, the Model 212K for klystrons, and the Model 212G for Gunn devices. For special requirements a custom version, the Model 212C, can be tailored to meet the demands of almost any specific application.

SPECIFICATIONS (preliminary)

	Model 212B	Model 212K	Model 212G
Drive capability	1 mA	1 mA	1 mA
Conversion Factor	40:1	1:1	1:1
Bandwidth	100 kHz	1 MHz	1 MHz
Dynamic Range	+/-10 V	+/-10 V	+/-10 V
Input Impedence	10 kohm	10 kohm	10 kohm
Isolation Device	opto coupler	opto coupler	op amp
Max Isolation Potential	3 kV	3 kV	50 V



CONNECTING AN EIP 578
TO A 705B



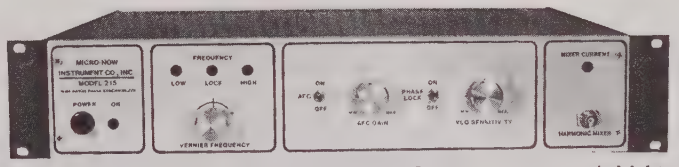
CONNECTING AN EIP 578
TO A 756

2/85

Micro-Now Instruments

MODEL 215

mm-Wave Source Phase Synchronizer



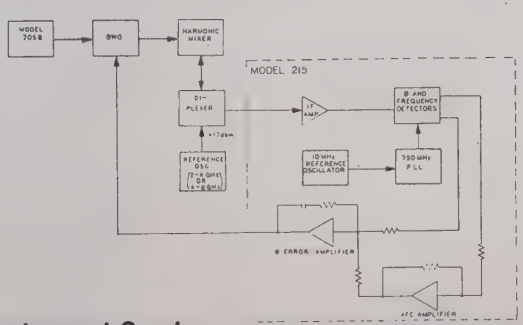
Micro-Now's Model 215 provides a high order of frequency stability for the output of mm-wave signal generators such as the Micro-Now Models 703, 705 and 706. It features a 500 MHz wide IF amplifier centered on 750 MHz and a broad-band phase/frequency detector. It requires an external harmonic mixer (available as an option from Micro-Now) and a 2-4 or 4-8 GHz high-stability external reference with an output between +10 and +17 dBm. A phase-locking circuit permits locking the internal 750 MHz oscillator to either the internal 10 MHz reference oscillator or an external precision 10 MHz source.
A GPIB interface, which permits fully automatic operation under computer control, is available as an option. Operation below 50 GHz requires a 2-4 GHz external reference; for 50 to 110 GHz operation a 4-8 GHz reference is needed.

PRELIMINARY SPECIFICATIONS

IF Amplifier:	Center Frequency -- 750 MHz* Bandwidth -- 500 MHz Gain -- 75 dB Connector -- BNC
IF Reference Oscillator:	750 MHz* +/-.01% (when locked to internal 10 MHz reference oscillator)
Capture Range:	+/-100 MHz
Lock Bandwidth:	-3 dB at 500 kHz
Options:	GPIB Interface
Power:	110/220 VAC, 50/60 Hz, 25 W
Dimensions:	19"(Rack) w x 3 1/2" h x 14" d
Weight:	15 lbs.

* Alternate IF frequencies between 650 and 850 MHz are available at added cost.

BLOCK DIAGRAM



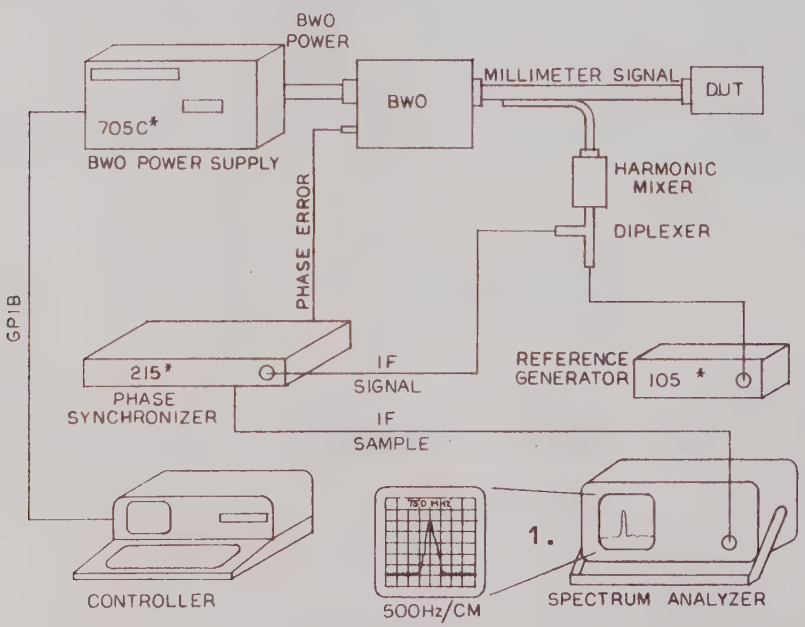
Micro-Now Instrument Co., Inc.
8260 North Elmwood Street, P.O. Box 1488, Skokie, Illinois 60076, (312) 677-4700

STABILIZING A MM-WAVE GENERATOR

USING A

MICRO-NOW MODEL 215

The block diagram below shows a mm-wave source stabilized with the aid of a Micro-Now Model 215 Phase Stabilizer, providing a very high stability signal to the device under test (DUT). The mm-wave source shown in the diagram is a Micro-Now Model 705B Power Supply and associated BWO source, while the reference is a Micro-Now Model 320X Reference Generator. However, any comparable equivalent instrument may be substituted without compromising performance.



* PRODUCTS OF MICRO NOW INSTRUMENT CO., INC.

1. Within a 500 kHz bandwidth, the phase noise of the mm-wave source is equal to 20 log(H) times the phase noise of the centimeter reference generator plus the phase noise observed at the 750 MHz IF of the Model 215 Phase Synchronizer. (H is the harmonic number of the reference signal used to down-convert the mm-wave signal.)

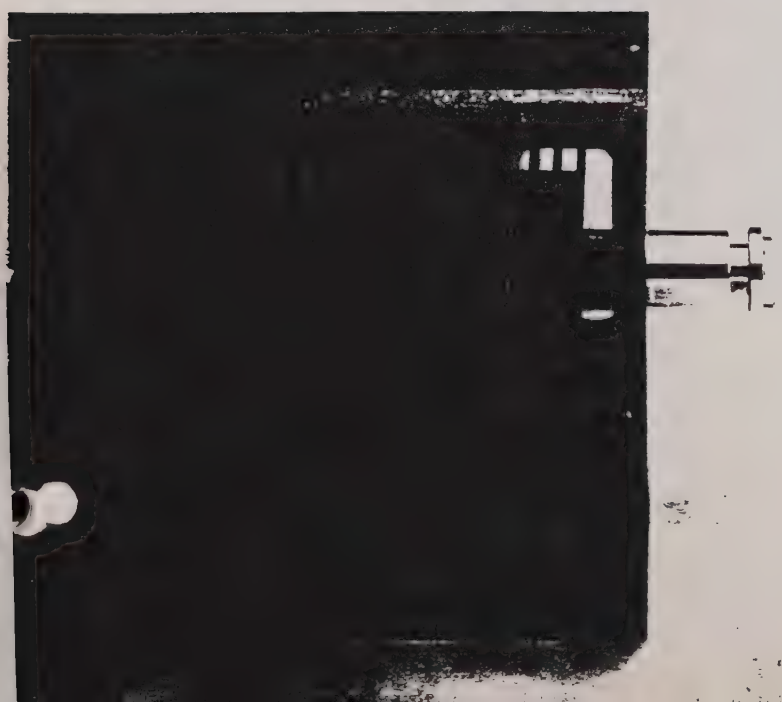
5/86

Micro-Now Instrument Co., Inc.

8260 North Elmwood Street, P.O. Box 1488, Skokie, Illinois 60076, (312) 677-4700

SIEMENS

Backward Wave Oscillators



Application

Siemens backward wave oscillators are millimeter wave oscillators for versatile applications. Fully covering the frequency range between 23 and 170 GHz, they are suitable for RF measuring tasks and for use in physical and chemical research and radar systems. Applications, such as equipment operation or development and testing of components, require microwave oscillators of low or medium power covering a broad tuning range, which can easily be amplitude- and frequency-modulated or swept. The backward wave oscillator (BWO) ideally meets these requirements. It can be tuned easily and almost inertialess without requiring any auxiliary mechanical device, just by varying the direct voltage in the slow-wave structure. In addition, the RF oscillation can be swept, or amplitude-modulated without power dissipation by keying the voltage at the beam-focusing electrode, and frequency-modulated by varying the slow-wave structure voltage. Some applications are described in the following.

Nuclear physics

Energy generation by thermonuclear conversion requires very high temperatures, which are produced in plasma layers focused by magnetic fields. The plasma characteristics are analyzed by means of electromagnetic waves (plasma diagnosis). The propagation characteristics of the wave give important information on carrier numbers, collision numbers and plasma temperature. Besides, instabilities and turbulences in the plasma can be detected with the aid of electromagnetic waves. Plasmas with high carrier densities, however, can only be penetrated by millimeter waves, longer waves are reflected. Therefore only millimeter waves can be used for measuring dense plasma.

Chemical research and development

The atomic vibration in the molecule produces spectra in the infrared range. The slower rotating movements of the molecules themselves, in contrast, cause absorption spectra in the millimeter wave range. If an electromagnetic wave of varying frequency passes a waveguide cell containing a polar gas, frequency ranges with high millimeter wave absorption can be observed. They are extremely narrow at gas pressures about 10^{-3} Torr. These absorption lines, which are characteristic for all gases with permanent dipole moment, are the basis of millimeter wave gas spectroscopy.

Short-range radar

In order to obtain good resolution the radio beam has to be extremely narrow and its wavelength must be short as compared with the object size. The dimensions of components and antennas are directly proportional to the wavelength of the beam to be focused, thus allowing the construction of small, compact devices for the millimeter wave range. These radar systems are particularly suitable for position finding and as landing aid in ports and on airports.

Meteorology

Atmospheric layers can be analyzed due to their selective absorption and reflection of millimeter waves. With the aid of cloud radar systems cloud height and vertical stratification, state of aggregation and relative humidity are determined.

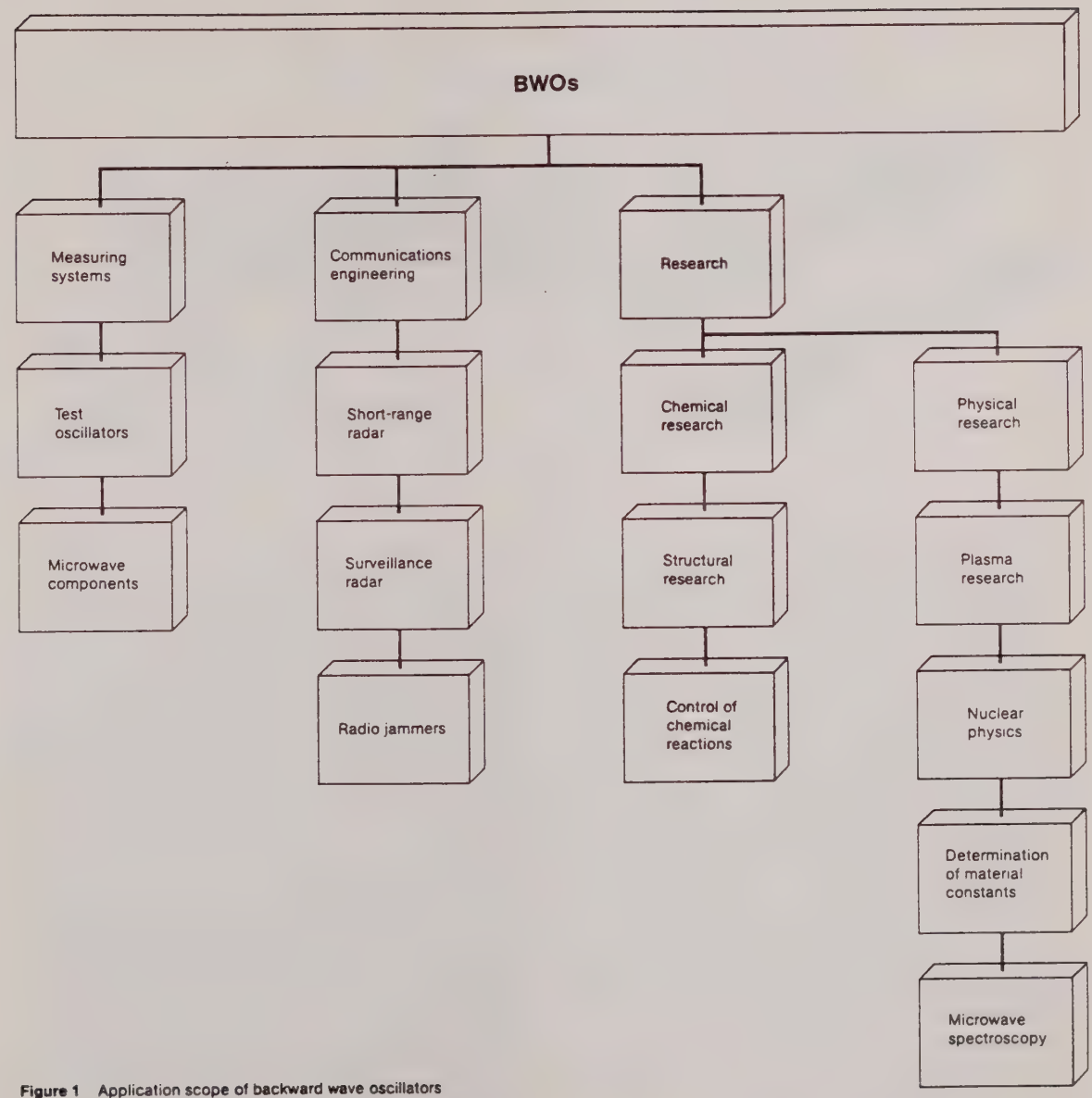


Figure 1 Application scope of backward wave oscillators

Construction and mode of operation

The backward wave oscillator operates on the basis of interaction between an electron beam and the longitudinal electric fields of a traveling electromagnetic wave. The energy of the wave propagates in the direction opposite to the electron movement, whereas the longitudinal electric field moves approximately synchronous with the electrons along a slow-wave structure. The feedback energy necessary to sustain a continuous oscillation results from the density modulation in the electron beam. In continuous operation the beam is density-modulated at the collector end. There it generates a feedback signal in the slow-wave structure, which grows along its path towards the gun end and modulates the electron beam. The higher the coupling impedance of the slow-wave structure, the more intensive will be the interaction between wave and electron beam.

Figure 2 shows a schematic section of a backward wave oscillator. Essential parts are the electron gun and the slow-wave structure.

The electron gun produces a high-density cylindrical electron beam carrying a current of 10 to 15 mA. The beam is focused in the interaction gap of the slow-wave structure by a permanent magnetic field. The interaction space is limited radially by the rims of the beam holes. The longitudinal electric field strength is highest between adjacent hole rims and falls off towards the beam axis. The diameter of the beam hole is designed such that the field strength across the beam cross section only slightly changes. The interaction of a cylindrical beam with rotationally symmetric fields has the marked advantage that the rotation of the beam around its axis caused by the shape of the magnetic flux curve does not impair the efficiency of the interaction process. After rotation about the beam axis, the electrons always encounter the same field configuration.

The electron gun has in addition to the beam-focusing electrode (BFE) G 1 and first anode G 2 a third electrode G 3. This electrode implements a flat slope of the magnetic field in the gun region and assures favorable conditions for the electron beam to enter the interaction region of the slow-wave structure over a wide range of circuit voltages. Fine adjustment of the G 3 voltage optimizes the output power and reduces noise. The G 3 electrode also prevents positive ions originating in the region of the structure from destroying the cathode. It therefore contributes to the long life of these tubes.

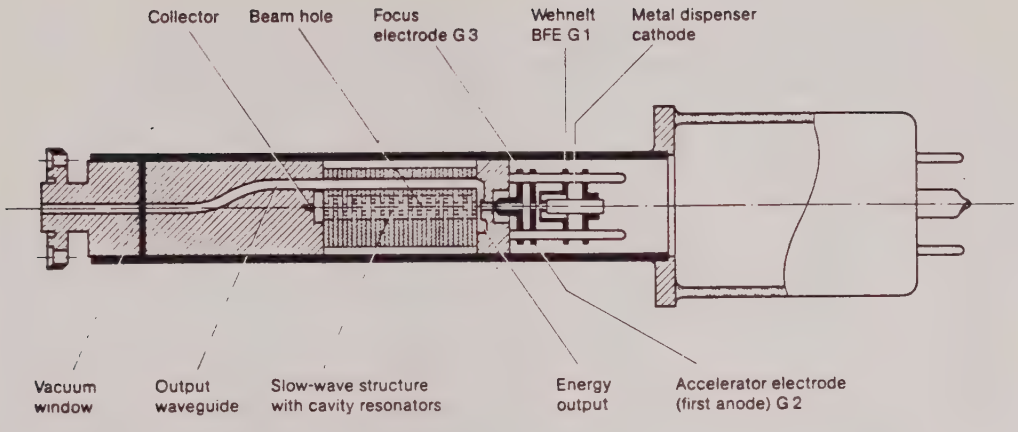


Figure 2 Longitudinal section through a BWO (schematic)

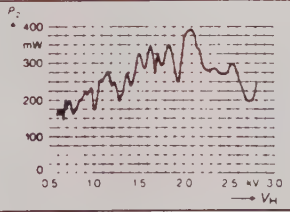
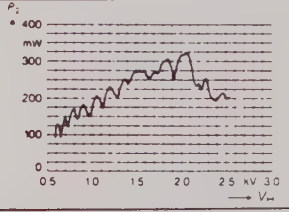
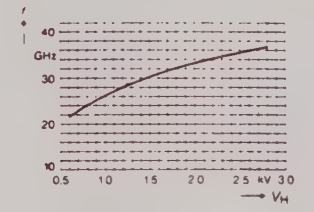
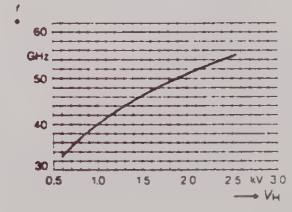
The slow-wave structure reduces the phase velocity of an electromagnetic wave to the velocity of the beam electrons and produces in the interaction gaps the strong longitudinal electric fields required for efficient interaction with the electron beam. The coupling impedance should be high, i.e. the wave power *P* must set up strong longitudinal electric fields in the beam region. The slow-wave structure must also be capable of rapidly dissipating the heat produced by RF losses and electron bombardment.

The slow-wave structure of the new backward wave oscillators consists of punched copper disks stacked in a jig and brazed together to form a compact rugged block. With no burred edges or flutes, the tolerance of the sheet metal determines the mechanical precision and electrical quality of the structure and consequently the reproducibility of the structure characteristics and frequency response of the tube. The heat developed by electrons impinging on the disk walls is transferred by the shortest route to the solid copper outer shell. As current densities of 40 to 160 A/cm^2 prevail and focusing this high-density beam in the tiny interaction gap is difficult, effective heat dissipation becomes a basic prerequisite for reliable performance.

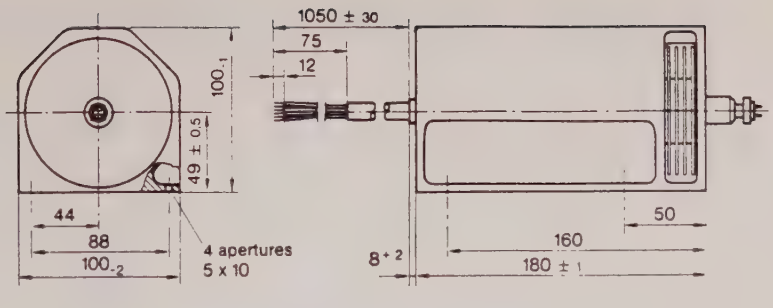
In the slow-wave structure the longitudinal electric fields concentrate in the small space between adjacent beam holes. Because of the low capacitive load, the coupling impedance is high. Short fingers and wide magnetic coupling slots between adjacent cells give the structure a broad tuning range despite its compactness. The RF losses in the structure are low because both the coupling impedance and the energy velocity of the wave are high, and wide low-loss current paths exist. A slow-wave structure for the 50 to 75 GHz range, for example, has an average attenuation of 2.5 dB. As the intrinsic attenuation is low, the collector end of the circuit must be terminated non-reflectively by a matched graphite wedge to obtain a continuous tuning characteristic.

The RF power output of the BWO is coupled out from the gun end of the structure and passes through a vacuum window to the load.

Summary of types

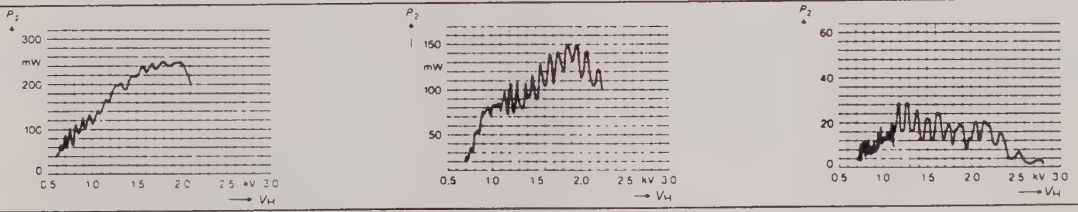
Type	RWO35S	RWO50S
Ordering code	**Q46-X3331**	**Q46-X3328**
Frequency range	23 to 35 GHz	33 to 50 GHz
Average output power	150 mW	100 mW
Minimum output power	≥50 mW	≥30 mW
Grid 1 voltage	−100 V	−200 V
Grid 2 voltage	1500 V	1800 V
Grid 3 voltage	200 V	200 V
Slow-wave structure voltage	500 to 2600 V	500 to 2600 V
Filament voltage	6.3 V	6.3 V
Connection flange	UG599/U	UG383/U
Waveguide	WR34	WR22
Weight	4.5 kg	4.5 kg
Output power versus slow-wave structure voltage		
Frequency versus slow-wave structure voltage		

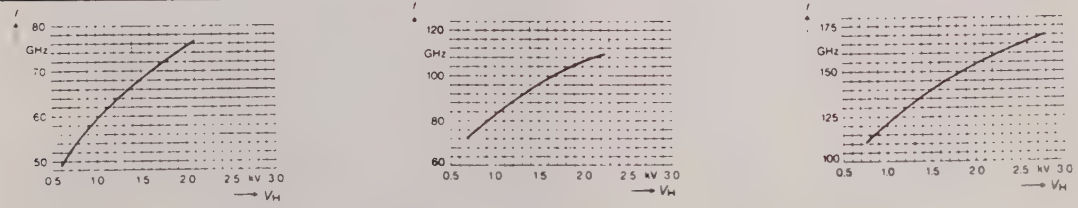
The five Siemens backward wave oscillators provide full coverage of the frequency range 23 to 170 GHz.
The most important technical data as well as the power curves are summarized in the table below.



Dimensions in mm

RWO75S	RWO110S	RWO170
Q46-X3323	**Q46-X3332**	**Q46-X3330**
50 to 75 GHz	75 to 110 GHz	110 to 170 GHz
40 mW	20 mW	10 mW
≥10 mW	≥5 mW	≥1 mW
−200 V	−250 V	−300 V
1800 V	2000 V	2500 V
200 V	250 V	350 V
500 to 2600 V	500 to 2600 V	500 to 2800 V
6.3 V	6.3 V	6.3 V
UG385/U	UG387/U	MIL-F-3922/74-002
WR15	WR10	WR6
4.5 kg	4.5 kg	4.5 kg





Power supply unit

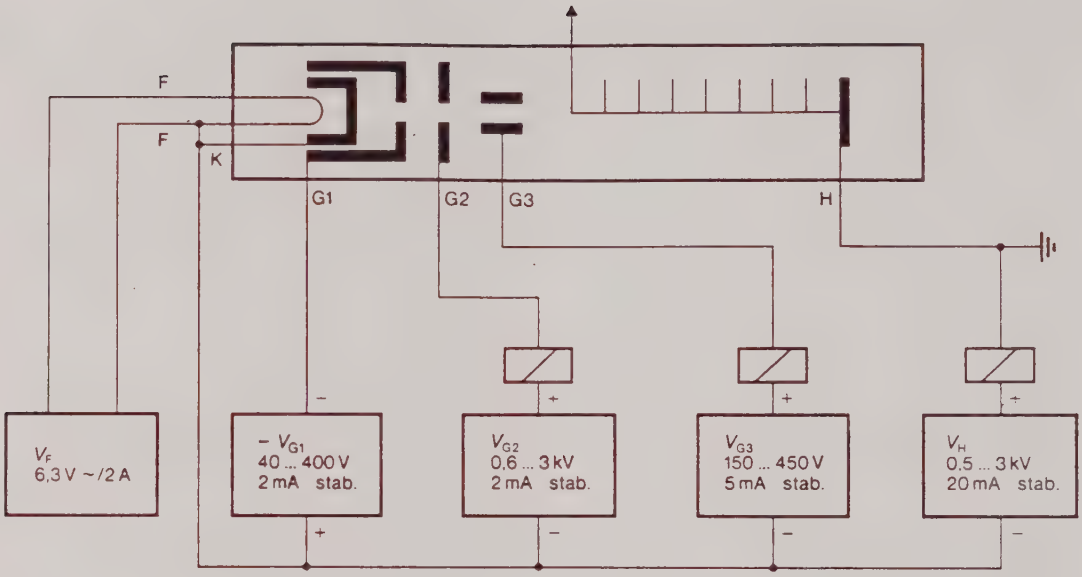


Figure 3

The power supply unit required for BWO operation is schematically shown in **Figure 3.** The voltage ranges are designed to ensure reliable operation of our BWOs. In order to obtain good frequency and power stability the operating voltages must be sufficiently stabilized.

A maximum potential of 3000 V to ground is applied to filament and cathode. The heater voltage transformer, therefore, has to be designed for this potential difference.

In order to protect the tube relays must be connected to grid 2, grid 3, and slow-wave structure supply line. If the permissible power dissipation is exceeded the relays turn off the grid 2 voltage. Moreover, the power supply unit is designed such that this voltage is also turned off in case of failure or disconnection of another voltage.

With regard to the service life of the tube the grid 2 voltage is only to be applied after a preheating period of 2 minutes (automatic grid 2 delay).

Special modes of operation

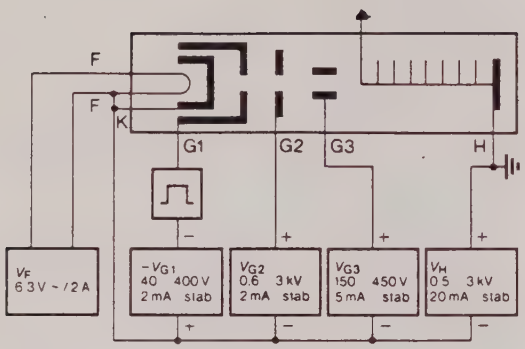


Figure 4 Amplitude modulation

Amplitude modulation

The amplitude can be modulated by superimposing the grid 1 voltage with square voltages as shown in **Figure 4.**

Either the negative grid 1 voltage, blocking the slow-wave structure current, is superimposed with positive square wave signals until the normal grid 1 voltage is reached, or the normal grid 1 voltage is superimposed with negative signals. It is important, however, to ensure that the pulses have a definite square shape in order to avoid additional frequency modulation.

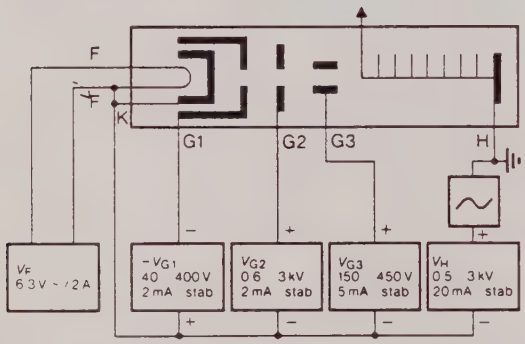


Figure 5 Frequency modulation

Frequency modulation

Backward wave oscillators can be frequency-modulated without any difficulty. The slow-wave structure voltage (V_H) just has to be superimposed with the required modulation voltage. The frequency modulation depends on the amplitude of the modulation voltage and on the frequency range. Generally, the modulation slope is less steep at the upper limit of the frequency range than at the lower limit.

Furthermore, it is possible to sweep the oscillator. For this procedure the sweep voltage (triangle or sawtooth) is superimposed with the slow-wave structure voltage.

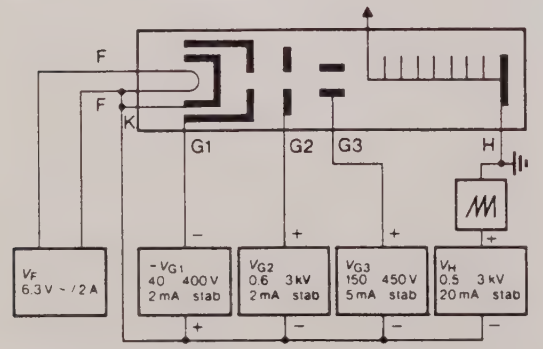


Figure 6 Sweeping

Operating instructions

Mounting

When mounting the oscillator, a minimum protective spacing of at least 150 mm has to be kept between the oscillator and other iron parts. Additionally a sufficient spacing to external fields must be provided.

Cooling

To dissipate the heat, the tube must be cooled with an air flow rate of about 150 l/min.

Starting operation

Color code of leads:

F	brown
F	orange*)
G 1	green
G 2	blue
G 3	red
H, ground	black
K	yellow*)

*) Connect filament (orange) to cathode (yellow)

In any case tube operation must be started in the following sequence (operating voltages for slow-wave structure, grid 3, grid 2 and grid 1 are indicated on the calibration curve of the tube):

1. Turn on air cooling.
2. Turn on heater voltage and preheat tube at least for 2 min. The grid 1, grid 3, and slow-wave structure voltages can be applied simultaneously with the filament voltage.
3. Turn on grid 2 voltage (V_{G2}) and adjust it to operating value.
4. Adjust tube to required frequency by setting the slow-wave structure voltage (V_H) according to the calibration curve supplied with each tube.
5. Maximize output power by fine adjustment of grid 3 voltage (V_{G3}).

Turning off

1. Turn off grid 2 voltage (V_{G2}).
2. Turn off remaining electrode voltages.

On no account, the slow-wave structure voltage (V_H) or the grid 3 voltage (V_{G3}) should be turned off first, since the tube may be damaged.

After prolonged interruptions of operation (about 6 months) it is recommended to preheat the tube about 15 min. prior to turning on the full electrode voltages. Subsequently, the tube should be operated at a reduced slow-wave structure voltage (V_H) of 600 V to 800 V for at least 1 hour. The remaining electrode voltages are to be adjusted to the normal operating values.

SECTION 5 TECHNICAL DESCRIPTION

5.0 TECHNICAL DESCRIPTION:

5.1 General System Organization.

5.2 Primary Power Distribution.

- 5.21 Main Power Distribution.
- 5.22 Relay Module Operation.

5.3 BWO Power Supplies.

- 5.31 Grid 1 Supply and Modulator.
- 5.32 Grid 2 Supply.
- 5.33 Grid 3 Supply.
- 5.34 Heater Supply.
- 5.35 Cathode Supply.
- 5.36 V1 Pass Tube, Grid, and Screen Supplies.
- 5.37 Digtial Voltmeter Supply.

5.4 Sweeper Section.

- 5.41 Lambda Power Supply - PS1.
- 5.42 Microcomputer Board - A1.
- 5.43 Display Buffer Board - A2.
- 5.44 Digital to Analog Convertor Board - A3.
- 5.45 Manual Sweep Circuit.

5.5 Analog Interface Organization.

- 5.51 Analog Processor Board - A4.
- 5.52 Auxiliary Board - A5.

5.6 General Interface Requirements.

5.7 Leveler Amplifier Operation.

5.0 TECHNICAL DESCRIPTION:

5.1 General System Organization.

The following sections are broadly divided into four discussions. First the BWO tube power supplies are described. Second, the Microcomputer sub-section is discussed. Then, the interfaces between the sections are detailed. Finally, the unit's external interfaces are described.

The Model 705C contains all circuitry needed to power the Siemens RWO series of backward wave oscillators, and may also be used to power BWO heads with Varian or Watkins Johnson tubes. Since these tubes employ a high voltage Cathode structure, with the RF power output flange at ground potential, all other tube elements, including the BWO heater, are referenced to the Cathode voltage.

All high voltage components are located in the right side of the unit, as viewed from the front. This arrangement, coupled with the fold down side panels, allows for ease of servicing.

The sweeper section is composed of individual circuit boards that hold the microcomputer, the computer's input and output interfaces, and the operational amplifiers and analog computer required to complete the system.

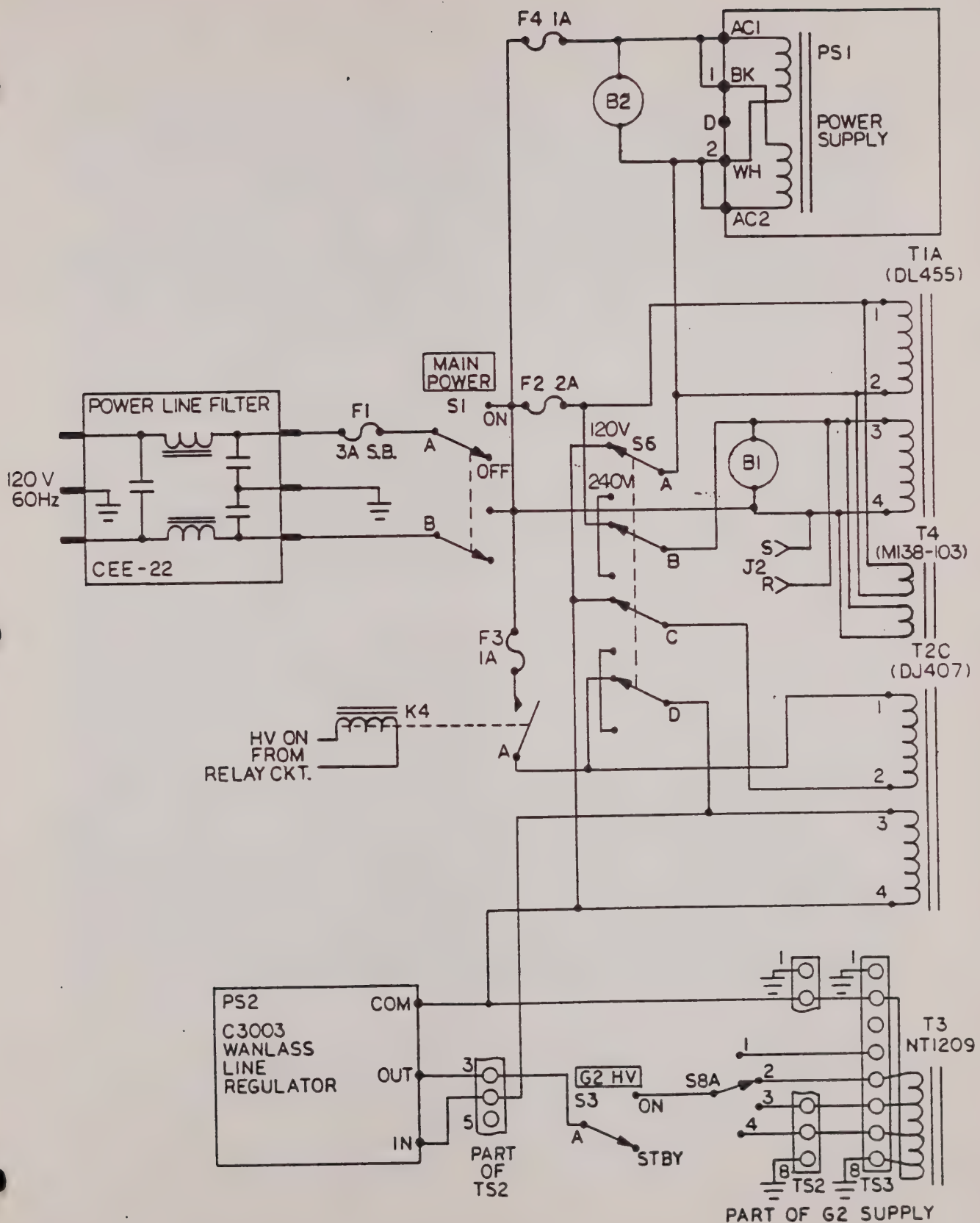
5.2 Primary Power Distribution.

5.21 Main Power Distribution.

The power input through the line cord passes through the fuse F1 on the rear of the unit and then through the Power switch S1 on the front of the unit. The power is then distributed to the various sections of the unit through the 120/240 V ac selector switch, S6, located at the inside rear of the chassis. The sections of the power distribution are: the low voltage supplies for the BWO tube power section, the high voltage supplies for the BWO tube power section, the low voltage supplies for the sweeper section, and the 120 V ac voltage to the BWO tube head.

The primary power to the low voltage supplies for the BWO power section feeds through the fuse F2 (located on the rear of the unit). It then goes through S6, sections A and B, to the primary of T1. In parallel with one of these primary windings, is the rear panel blower, B1, for the power supply section and pins R and S of the BWO Power cable connector, J2. These pins (R and S) enable the blower and elapsed time meter for the BWO enclosure.

The DVM power supply transformer T4 is also in parallel with T1A primary windings.



705C PRIMARY POWER DISTRIBUTION

FIGURE 5.2

5.21 Main Power Distribution (Cont'd).

The primary power for the HV supplies connects through fuse, F3, located on the rear panel. Power then goes through the contacts of relay K4, which is located on the relay module assembly. It then goes through sections C and D of S6, to the primary of the HV supply transformer T2. The EG2 line regulator is connected in parallel with one of these primaries.

The primary power for the low voltage supplies in the sweeper section connects through fuse F4, located on the rear of the unit, and then through sections A and B of the 120/240 V ac selector switch to the primaries of PS1, the sweeper section power supply. The blower for the sweeper section, B2, is connected in parallel with PS1 primary.

5.22 Relay Module Operation (See Figure 7.30).

DC RELAY SUPPLY

Power for the 705C relay system is derived from A19Q1, an emitter follower, driven by a three terminal IC regulator. Diode, D8, biases the regulator common, approximately +0.6 volts with respect to ground, to compensate for the base-emitter drop of Q1. The +24 V dc is used throughout the unit, for relay and indicator power.

Relay operation will be described for normal power on sequencing, then various overload operations will be discussed.

POWER ON SEQUENCE

S1 Main power switch energizes transformer T1. 24 V ac is applied to the relay supply's bridge rectifier D2. The regulated 24 V dc from Q1 emitter illuminates I1 Power On LED. If S5 interlock is closed and thermostat switch is closed, delay relay K1 starts to heat. At the end of the 120 second delay (which allows the BWO being powered the correct pre-heat filament time) K1 contacts close. This closure supplies ground to K2 relay by way of K2A, BWO cable, thermostat switch and S5 interlock. K2A contacts close, latching K2 on. Also, ground is removed from K1 which de-energizes . K2B contacts supply ground to I2 and the green "Standby" LED lights.

HV ON SEQUENCE

When S2 HV switch is turned on, K3 coil is grounded through S2A, and +24 V is applied to K3 coil through K6A n.c. contacts. K3 energizes; K3A contacts supply +24 volts to S3B n.o. and G2 HV green "Standby" LED lights. K3B contacts close and supply ground to K4 (which energizes). K4B contacts close, ground is applied to R7 and +24 volts is applied to I2 HV (red) LED from S2B contacts. K4A contacts close, and AC power is applied to HV transformer T2. At this time, G3, G1 and Cathode HV should be present and can be checked and adjusted by front panel controls.

G2 HV ON SEQUENCE

G2 HV switch S3 is turned on; S3B contacts supplies +24 V to K10 relay coil from K3A (energized) and K6A n.c. Also, G2 ON (red LED) lights. K10 relay operates, removing 20K 10 watt resistor from G2/Cathode and connecting G2 supply to J2C. S3A contacts supply regulated ac line voltage to T3 of the G2 power supply which energizes. G2 can now be checked and adjusted by front panel controls.

OVERLOAD OPERATION

EG2 and EG3 supplies are provided with current sensing overload relays in their output lines. If either G2 or G3 draw excessive current (2 mA. K7 or 7 mA. K9 respectively) their contacts will close. Contact closure applies 26 V ac to slave relay K12. The slave system is used to provide the necessary high voltage isolation, since these supplies are "floating" on the HV Cathode supply. K12 energizes and ground is applied to K8 through the normally closed "Reset" switch (S4).

K8 energizes; K8B contacts close and latch the relay. K8A contact opens, which causes K10 to de-energize, removing G2 HV from BWO. Also, "G2 ON" indicator is extinguished. K8A n.o. contact closes and ground is applied to K6 which energizes. K6B n.c. contact opens, K4 relay de-energizes. All HV supplies go off as T2 primary voltage is removed due to K4A open contacts. K6B n.o. contact closes and I5 "Overload" LED starts to flash. K6A contact opens and K3 de-energizes, causing "HV ON" LED to extinguish.

Helix overcurrent is sensed by relay K11 which is located in the Cathode High Voltage supply return line. It is factory set for a 20 mA operating point. In the event that excessive current is drawn from the supply, K11 energizes, K11 contact closes and ground is applied to K8 through the normally closed "Reset" switch. Operation continues as described above.

OVERLOAD RESET

When the overcurrent problem has been resolved (usually by reducing supply voltage outputs) power is restored as follows: Reset switch S4 is depressed momentarily, which removes the ground from K8 coil which is de-energized. K6 de-energizes by K8A contact opening. K3 now is energized by K6B contact closure, and operation continues as described in the HV ON sequence.

THERMO/INTERLOCK OPERATION

In the event the 705C suffers an open in the 24 V dc supply ground return by: top cover interlock, BWO thermo switch, or BWO cable disconnect; all relays are de-energized and the system high voltage is disabled. To indicate this problem, a flashing red "Thermo/Interlock" LED is provided. Circuit operation is as follows: When S5, Thermo switch or BWO cable is open, the voltage at the junction of R3, R4, Q1 base will rise towards +24 V, A25Q1 Darlington's emitter follows this rise and I4 LED will begin to flash.

5.3 BWO Power Supplies.

Five power supplies are required for the proper operation of Siemens BWO tubes. (Refer to Section 3.1). Four of these supplies, heater, G1, G2 and G3, are referenced to the Cathode of the tube. The fifth supply, Cathode to Helix, is referenced to ground.

The three grid supplies use a common principle of operation. This common principle will be discussed in this section, and then all five supplies will be described in greater detail in individual sections.

GRID VOLTAGE POWER SUPPLIES

The G1, G2 and G3 voltage power supplies are designed around the MC1466L floating voltage regulator, and an external pass transistor. Figure 5.3 shows the basic block diagram.

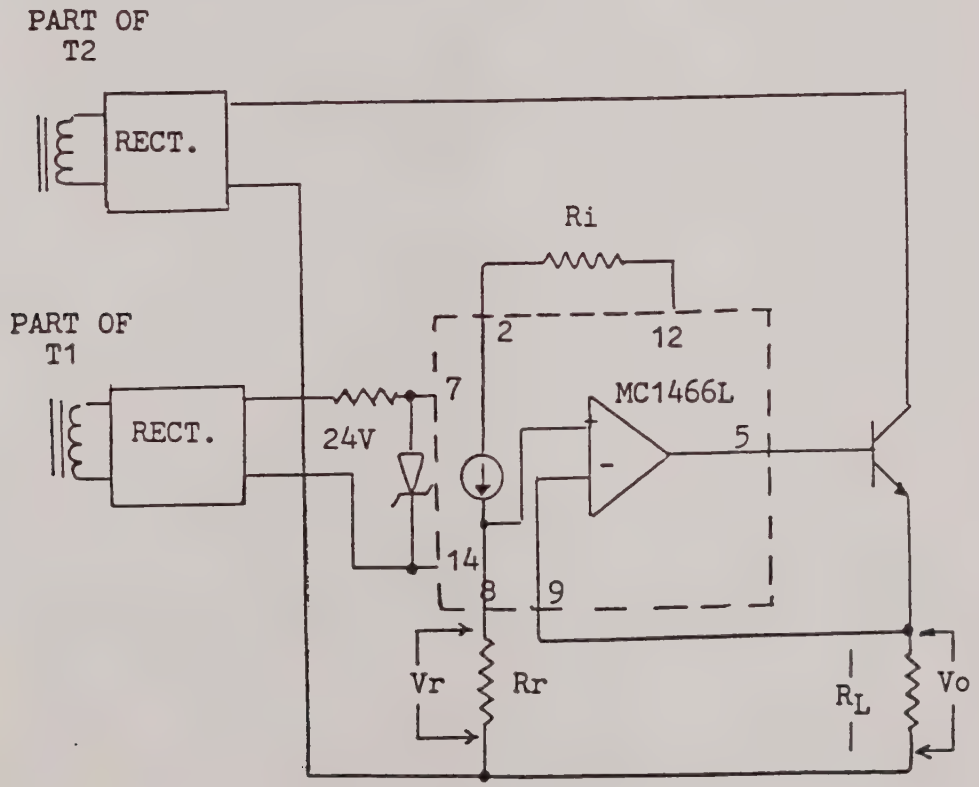


FIGURE 5.3

OPERATION

The voltage regulator IC is operated from a zener regulated power supply that is completely separate from the unregulated grid supply. This IC contains a constant current generator and a differential amplifier. The current generator's output current is set by resistor Ri, typically to 1.0 mA. The reference voltage for the error control amplifier is developed across Rr by the current generator.

5.31 Grid 1 Supply and Modulator (See Figure 7.11).

The modulator and power supply for Grid 1 are contained on three separate circuit boards, assemblies A11, A12, and A13, respectively. A primary ac voltage of 440 volts is derived from terminals 5 and 6 of transformer T2. This voltage is rectified and filtered to 600 V dc. The auxiliary supply voltage for the regulator is derived from terminals 17 and 18 of transformer T1 and then rectified, filtered and zener regulated to 24 V dc. R9, the 8.66K resistor, sets the constant current generator to 1.0 mA. R11 and R12, which add to 475K, set the reference voltage to 475 V. The error signal is fed to the base of the series pass transistor, Q1. Automatic current limiting is provided by R6. When a 250 mV drop appears across this resistor, the supply output drops toward zero.

The modulator is powered by the G1 475 V supply. Q1 is an emitter follower. The input voltage for the follower is derived from the voltage divider chain R5, R6, and R7. G1 output is referenced to +EG1. The unmodulated output voltage may be varied from 160 to 360 volts as R6 is varied.

The modulation signals for control of Grid 1 are all provided from the Leveling Amplifier (See Fig. 5.7) and are referenced to ground. Modulation signals appear at the input to the opto-isolator IC1 (H11A20). The output of the isolator is amplified by Q4 (2N2405) and then by the modulation transistor Q2 (2N3439). The circuit is biased so that a +5 volt modulation signal at the opto-isolator input will result in G1 being pulled by Q2 to greater than -400 V, cutting the BWO tube power output off.

5.32 Grid 2 Supply (See Figure 7.14).

The Grid 2 supply is contained on three circuit board modules, in addition to a multi-tap transformer and a line voltage pre-regulator. The circuit boards are: A18, the rectifier board; A17, the regulator or main board; and A16, the coarse range adjust board.

The regulator operates in the same manner as previously described, with these exceptions to allow for a wider voltage range. The ac input voltage to T3, the G2 high voltage transformer, is pre-regulated by a Wanlass brand line voltage regulator; This prevents the voltage drop across the G2 regulator pass transistor from exceeding the voltage breakdown of this transistor under high line voltage conditions. There are five input taps on T3, which correspond to the four G2 coarse ranges. In tandem with T3, the reference resistor is also switched. R10 is the fine voltage control: 500K corresponds to a 500 volt range. K7 is the overcurrent relay, set for 2 mA by shunt resistor RS1.

5.33 Grid 3 Supply (See Figure 7.19).

The Grid 3 supply consists of A15 Rectifier board, and A14 Regulator board. A15 provides a filtered and rectified dc voltage of approximately 600 V to the Regulator board, terminals P1401-2 and 18. The 24 V dc auxiliary voltage is supplied at terminals P1401-5 and 7. Resistor R9 (8.66 kohm) sets the Regulator's reference current to 1.0 mA. R10 and R11 allow control of the G3 output voltage from about 165 to 420 volts. The supply can source up to 10 mA current. R10 is provided as a 10 turn fine control on the front panel for critical tuning of the BWO operating point. An external overcurrent relay (K9) is set to operate at 7 mA and will sequence the HV power supplies to an off-HV overload condition.

5.34 Heater Supply (See Figure 7.23).

The heater supply for Siemens BWOs is current regulated by a ballast regulating tube. This regulator automatically absorbs line voltage fluctuations and also acts to allow slow warm up of the BWO at power turn on. A pair of back to back zener diodes are employed to limit the heater voltage in the event of severe over-voltage conditions. An internal 1.5 amp fuse is also provided for excessive current protection. The heater voltage is adjustable over a range of 4 to 7 volts by use of the rear panel rheostat. This entire supply is isolated from line and frame by 3kV, allowing the recommended heater to Cathode connection to be made at the BWO tuning head.

5.35 Cathode (Helix) Supply (See Figure 5.35).

The Cathode supply provides the variable high voltage potential which allows voltage tuning of the BWO RF output frequency. The supply is entirely solid state with the exception of the ceramic tetrode series regulator tube. The high voltage output is controlled by low voltage tuning signals derived from the Cathode to Helix voltage regulator and pass tube grid driver section of the Analog Processor board (A4). These control signals originate from the front panel frequency control potentiometers and are modified by switching and processing circuits controlled by the microprocessor to produce the various CW and swept frequency operations. The necessary dc and ac feedbacks from the high voltage output line are fed through separate circuits to the control signal junction point of the grid driver operational amplifier. The closed loop responses of these circuits provide the tight dc stabilization and high ripple rejection inherent in a series pass regulator circuit.

Since Backward Wave Oscillators have a non-linear frequency versus voltage tuning curve, the dc feedback signals are fed back through a linearizing network for compensation. The analog frequency control signals are converted to a digital display frequency by the microprocessor using data stored on an EPROM that has been individually tailored for the specific BWO being powered. As a result, the front panel displays indicate BWO operating frequency within 1%, directly calibrated in GHz, without having to resort to cumbersome dial cords and changing dial plates as BWOs are changed.

The Cathode to Helix voltage range can be reduced or increased to service special BWO heads. This is accomplished by changing the position of the Cathode high voltage adjust jumper on the rear panel (**system high voltage must be off**). Position 1 gives a nominal voltage range of -340 to -1685 volts, position 3 gives a calibrated voltage range of -550 to -2650 volts, and position 2 or 4 gives a nominal voltage range of -600 to -3000 volts. The BWO head has been frequency calibrated for use with one of these ranges, and the correct range is designated in the operating instructions for that head. In general, Range 1 is used with Varian BWOs, Range 3 with most Siemens BWOs, and Range 2 or 4 to extend the frequency output range of 22 to 35 GHZ, 75 to 110 GHz, and 110 to 170 GHz Siemens BWOs (RWO 35, 110, and 170 respectively).

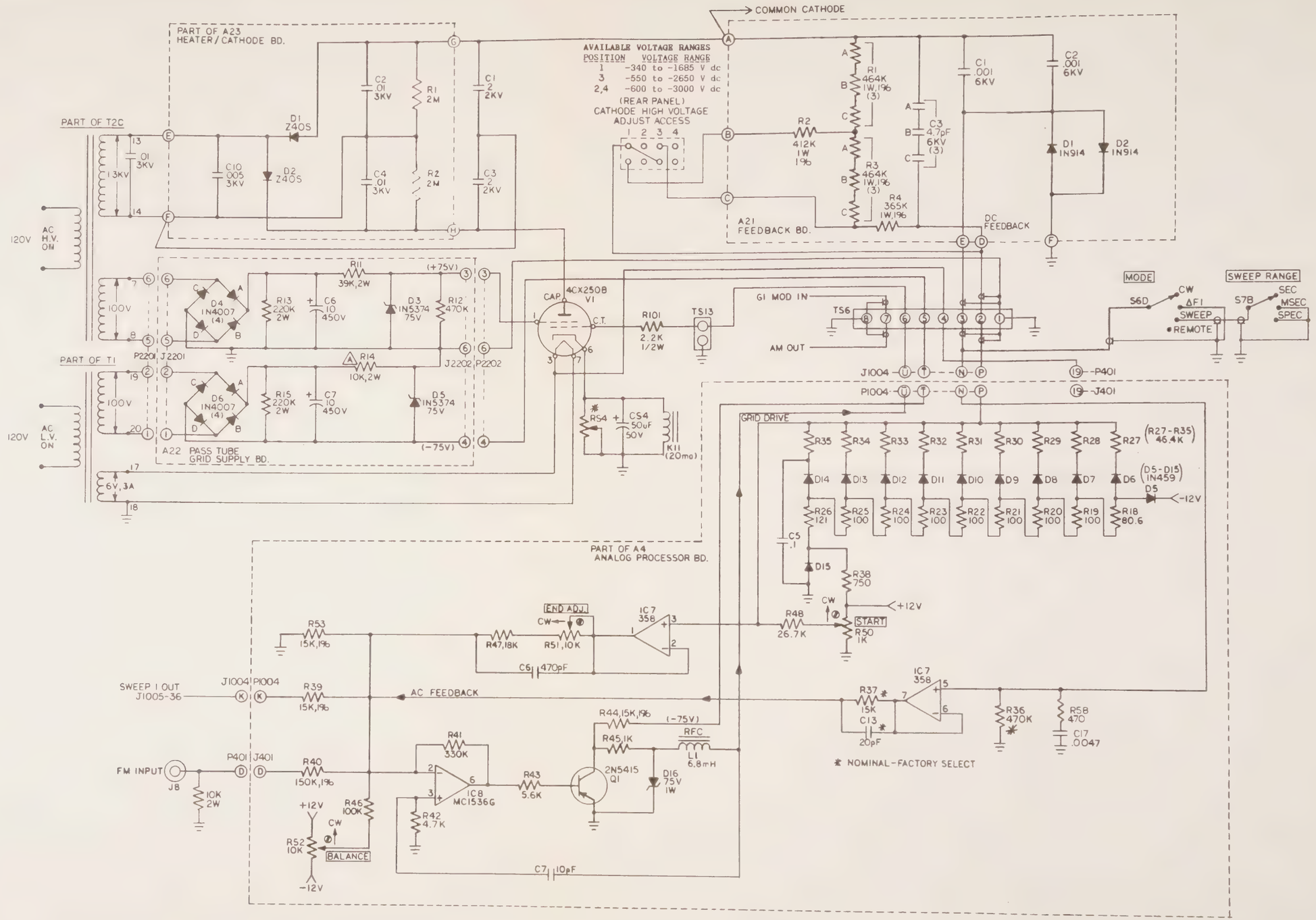
In CW, Seconds Sweep, and Remote Modes, the frequency response of the Cathode to Helix supply is reduced by connecting an ac feed back signal from this supply back to its regulator. The ac feedback connection, sometimes called a CW filter, acts to reduce the supply ripple, and therefore reduces the residual FM of the output signal.

5.36 V1 Pass Tube, Grid, and Screen Supplies (See Figure 5.35).

The pass tube grid supplies are located on unit A22 in the vicinity of the 4CX250B (V1) socket. They are identical supplies (except for polarity) and use full wave bridge rectification, capacitive filtering and zener diode regulation. The +75V screen grid is fed directly to the V1 pass tube terminal 1. The -75V control grid bias for the Cathode to Helix supply pass tube is fed to the output stage of the Cathode supply regulator, Q1 (2N5415), part of A4 Analog Processor.

5.37 Digital Voltmeter Supply (See Figures 7.8 and 7.30).

The Digital Voltmeter supply consists of a transformer T4 located on the center panel and the DVM Power Supply Board A8 also on the center panel. The power supply board consists mainly of a bridge rectifier and a voltage regulator to provide 5 volts to the digital meter.



ALL RESISTANCES IN OHMS.
ALL CAPACITANCES IN MICROFARADS
UNLESS OTHERWISE NOTED.

MICRO-NOW INSTRUMENT

SCALE: NONE	APPROVED BY: BB WPJ	DRAWN BY MRA
DATE: 10/21/82		REVISED

ECN 705114 MRA 2/8/83
ECN 705121 MRA 6/6/83
ECN 705125 RJ 9/2/83
ECN 705137 WES 3-21-84
ECN 705143 MRA 11/29/84
ECN 705153 MRA 4/22/85
ECN 705205 MRA 3/27/86
ECN 705213 MRA 3/27/86

MODEL 705C CATHODE TO HELIX SUPPLY

DRAWING NUMBER FIG. 5.35

18224 PRINTED ON NO. 1000H CLEARPRINT

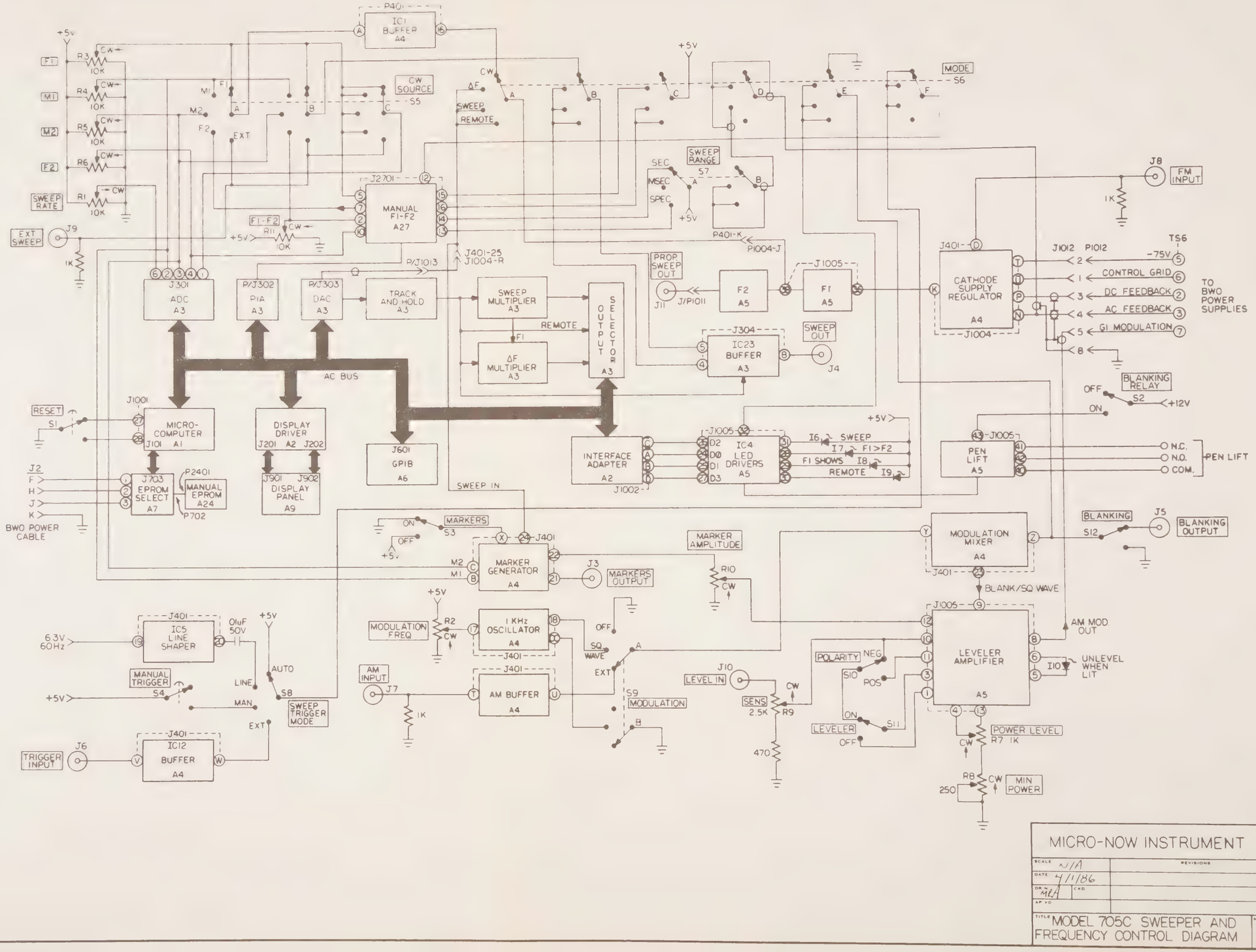
5.4 Sweeper Organization (See Figure 5.4).

The microprocessor controlled sweeper system has been built in a completely modularized configuration to ease trouble-shooting and maintenance. The major card assembly consists of 5 large circuit cards which plug into a main "Mother Board" (Unit A10). This unit also contains 9 other connectors which distribute power and signals in and out of the main circuit cards. These connectors are listed below and their main functions are described:

MOTHER BOARD CONNECTORS	FUNCTION
J1006	GPIB/IEEE Interface Cable
J1007	Leveler Cable to front panel
J1009	LED driver to front panel
J1010	Blanking relay contacts to rear panel
J1011	Proportional sweep to rear panel
J1012	Cathode/Helix supply cable to TS6
J1013	Sweep Input from A3 (J303)
J1015	Front panel reset
J1016	+/-12 V power from PS1

The 5 main circuit cards also have several cables which distribute information. They are described below:

UNIT	TITLE	JACK #	FUNCTION
A1	Microprocessor	J101	Interconnects A7 ROM/RAM Select
A2	Display Buffer	J201	Interconnects A9 Digital
		J202	display unit
A3	Digital to Analog Convertor	J301	Interconnects front panel frequency and sweep pots
		J302	Interconnects front panel sweep controls
		J303	DAC sweep output coax to A4 (J1013)
		J304	Interconnects front panel sweep switching
A4	Analog Processor	J401	Control signals
A6	IEEE 488	J601	Microcomputer Bus
		J602	+5 V power
		J603	IEEE connector
A7	ROM/RAM Select	J701	LED signals
		J702	ROM select
		J703	Microcomputer Bus
A9	Display Panel	J901	Displays - Odd
		J902	Displays - Even



MICRO-NOW INSTRUMENT

SCALE N/A	REVISIONS	BY	DATE
DATE 4/1/86			
DR'N MLA CK'D			
AP'VD			

TITLE MODEL 705C SWEEPER AND FREQUENCY CONTROL DIAGRAM

NO FIG. 5.4

BRUNING 40-105

5.4 Sweeper Organization (Cont'd).

The sweeper section may be organized into five sub-sections: power supply, frequency controls, frequency displays, amplitude modulation chain, and Cathode to Helix supply regulator. An overall block diagram of this section is shown in Figure 5.4. The power supply is described in Section 5.41.

The frequency controls include the F1, M1, M2 and F2 potentiometers, a 12-bit digital to analog convertor which generates the sweep ramp under micro processor control, the mode switch, the sweep rate range switch, the sweep rate control, and the CW source selector switch. The frequency output of the sweeper is controlled in a different fashion in each of the four operating modes: CW, Delta-F, Sweep, or Remote.

In CW mode, the operating frequency is controlled by one of the four frequency control potentiometers, or a 0 to +5 V external voltage source as selected by the CW source selector switch. The desired control voltage is buffered by a voltage follower on A4, the Analog Processing module. The output of this buffer passes through the CW select contact on the Mode Selector switch and then through a 20 kHz corner low pass filter on A5, the Auxiliary module. The output of this filter returns to A4 and then to the input of the Cathode to Helix supply regulator; it also is directed to the Proportional Sweep BNC connector on the rear panel. The 0 to +5 volt frequency control signal is amplified with a gain of two and connected to the Sweep Output BNC on the front panel.

In Delta-F Mode, the operating frequency is controlled by the algebraic addition of the selected CW Source control voltage and the symmetrical sweep ramp output of the digital to analog converter. This addition is performed by the Delta-F multiplier on the A3 board. The output of this multiplier is selected by a CMOS switch also located on this board. The composite signal is selected by the Delta-F position on the Mode switch, filtered by the 20 KHz low pass filter on the A5 board and then routed back to the input of the Cathode to Helix supply regulator.

In Sweep mode, the sweep signal, and the F1 and F2 control signals are combined by the sweep multiplier on the A3 board. The output of this multiplier is selected by a CMOS switch located on this board. The sweep signal is selected by the Sweep position on the Mode switch, filtered by the 20 KHz low pass filter on the A5 board and then routed back to the input of the Cathode to Helix supply regulator.

In Remote Mode, the output of the sweep DAC is selected by the CMOS switch and the Mode switch , filtered by the low pass filter on the A5 board and then routed back to the input of the Cathode to Helix supply regulator.

The frequency display system includes an analog to digital converter, a microcomputer, a peripheral interface adapter, the display drivers, and the seven segment displays.

The wiper voltages of the four frequency controls and the Sweep Rate control are routed by shielded cable to A3. A 12 bit ADC on this module digitizes these voltages. The digitized voltage is processed by the Microcomputer and converted to a numerical frequency or sweep rate. The numerical frequency is routed to the corresponding display driver on A2, the Display Buffer module, and then to its four digit display.

Four additional status flags are buffered by an interface adapter on A2, and routed to an LED driver on A5, the Auxiliary module. This driver services four LED indicators: Sweep, F1>F2, F1 Shows Operating Frequency and Remote.

The amplitude modulation chain includes the marker generator, the 1 kHz oscillator, the retrace blanking generator, a modulation mixer, a leveling amplifier, and a buffer for external AM.

The marker generator, part of A4, compares the ramp voltage in sweep mode to the wiper voltage of the two marker control potentiometers. When the ramp voltage is equal to the marker control voltage, an output pulse is generated. This marker pulse is fed to the input of the Modulation mixer, also part of A4. The markers may be turned on or off by a front panel control.

The retrace blanking signal is derived from the sweep flag output of the microcomputer. The blanking signal is routed through the Delta-F and Sweep positions of the Mode Selector switch and then through the blanking on-off switch and the modulation mixer, part of A4.

The 1 kHz oscillator is also on A4. It is a symmetrical square wave oscillator whose frequency is controlled by the wiper voltage of the frequency control pot. The oscillator is enabled and its output selected by the square wave position of the Modulation switch. The square wave signal is routed to an input of the modulation mixer.

The output of the external AM buffer may also be selected by the Modulation switch and routed to the modulation mixer.

The leveling system permits the BWO tube to be linearly modulated as part of a negative feedback power control loop, and it buffers the digital logic output from the modulation mixer before it is coupled to the G1 Grid modulator circuit.

5.41 Lambda Power Supply - PS1 (See Figure 7.27).

The Sweeper section is powered by a Lambda Model LOT-X-5152-A modular power supply. This power supply includes over-voltage and overcurrent protection circuits. It is adjusted to provide 5.00 volts, +12.00 volts, and -12.00 volts. These voltages are distributed through the unit in a manner that reduces the noise on the power buses to a minimum.

5.42 Microcomputer Board - A1 (See Figure 7.1).

The microcomputer board contains the microprocessor, clock, RAM, ROM, and bus interface circuits required for its proper operation. The clock IC, 6875, and 6 MHz crystal generate the 1.5 MHz timing signals for 68A00 microprocessor. Two 74LS244 I.C.s buffer the address bus of the 68A00 and a 74LS138 decodes the selector lines for the address banks. The address banks are divided as follows: Bank 0000 is a 1K RAM used for a scratchpad memory. Memory bank 2000 is assigned to the GPIB adapter. Memory bank 4000 is assigned to the front panel displays and digital to analog convertors.

Memory bank 6000 is the ROM that calculates the frequencies displayed on the digital dials. The 2732 EPROMs that contain this information plug into the EPROM Select Board, A7, that is mounted to the left side panel. Address bank 8000 is used for the diagnostic program. The stack RAM is located at A000. The address bank at C000 contains an EPROM programmed with a library of utility subroutines and E000 holds the EPROM with the GPIB service programs. Two 74LS37 and two 74LS242 ICs are used as bi-directional buffers and bus drivers.

The EPROM Select Board, A7, permits the user of the unit to automatically change frequency dials when the BWO tube is changed.

5.43 Display Buffer Board - A2 (See Figure 7.2).

The front panel of the Model 705C has four digital displays and four individual LEDs. These displays are updated by the microcomputer through the Display Buffer Board, Fig. 7.2. The microcomputer updates each display by "writing" to the display's interface adapter. The buffer memory provided allows the microcomputer to perform other activities when the displays are not being serviced.

Two ICM7218C integrated circuits drive the digital displays. These drivers contain the memory buffers, binary to decimal converters, constant current segment drivers, and segment by segment multiplexing circuitry.

A 68A21 programmable interface driver is used as an output data port for the status flags that are displayed on front panel LEDs. An additional control bit is used to switch the deglitching circuit (located on the Analog Processor board) between track and hold.

Two 74LS138 and one each 74LS148, 74LS27, and 74LS32 integrated circuits are used as address decoders for the data buffers on this board. A 74LS240 is used as a bi-directional data bus driver.

5.44 Digital to Analog Convertor Board - A3 (See Figure 7.3).

The Digital/Analog Converter (A3) board contains both the analog to digital converter for the front panel controls, the sweep generating digital to analog converter, the Delta-F and Sweep multipliers, the deglitching track and hold amplifier, and an input port to sense the position of the Mode and Sweep Rate switches on the front panel.

The input to the analog to digital decoder is multiplexed among the F1, M1, M2, F2 and sweep rate controls by two 4016 CMOS switches, IC1 and IC2. The multiplexer setting is determined by the microprocessor via a 6821 PIA, IC8, a 7442 BCD to decimal decoder, IC6, and a 7404 hex inverter, IC4.

The analog to digital conversion is performed by a 7533 10 bit digital to analog converter, IC6, and a TL082 high speed comparator, IC3. The DAC is programmed via a 6821 PIA, IC7. The conversion is performed by successive approximation.

5.44 Digital to Analog Convertor Board - A3 (Cont'd).

Sweep generation is performed by a 7541 12 bit DAC and a 358 dual op amp. One half the op amp is used to generate a -5 volt reference signal that is used by both DAC's on this circuit board. The DAC output is programmed by the microprocessor via a 6821 P1A, IC9.

The output of the sweep DAC is deglitched by a AD582 track and hold amplifier and then processed into F1 to F2 sweep by a 534 multiplier, IC21 or into Delta-F sweep by a 534 multiplier, IC22. The desired function, sweep, Delta-F or remote is selected by a 4053 CMOS switch and routed to J303, the sweep output connector.

5.45 Manual Sweep Circuit (See Figures 5.4 and 7.34).

The Manual Sweep circuit uses an analog multiplier IC, AD534JD, to combine the manual sweep signal, generated by the control potentiometer (concentric with the CW Source switch), with the signals from the F1 and F2 frequency controls. The output of the multiplier is selected when the CW Source switch is in F2 position, and in this position, the Sweep Output on the front panel tracks the manual sweep control.

The trimmer potentiometer, R2, located on the Manual F1-F2 Board (A27), adjusts the scaling factor of the multiplier circuit. This circuit may be adjusted by setting the front panel controls on the unit for manual sweep, setting the F1 control for a wiper voltage of 1.25 volts, and the F2 control for a wiper voltage of 3.75 volts. Trim R2 so that the output of the multiplier circuit, J2701 pin 7, swings from 1.25 to 3.75 volts, as the F1-F2 control is turned from its minimum setting (CCW) to its maximum setting (fully CW).

5.5 Analog Interface Organization.

The backward wave tube power supplies are interfaced with the sweeper and frequency control section of the unit in two places: the Cathode to Helix supply and the G1 modulator. The chain of control for each of these systems is diagrammed in illustration 5.35 for the Cathode to Helix supply and 5.7 for the G1 Modulator.

5.51 Analog Processor Board - A4 (See Figure 7.4).

The Analog Processing Module (Figure 7.4) includes, in their order of description: the CW mode voltage follower, the Cathode to Helix supply regulator, the DAC deglitching circuit, the Delta-F Mode level shifter, the marker generator, the 1 kHz VCO, the amplitude modulation mixer, and the sweep trigger buffer.

The CW mode voltage follower, one half of IC1, presents a high impedance to the selected CW source and therefore maintains the linearity of voltage with the rotation of a control potentiometer.

The Cathode to Helix Supply Regulator is illustrated in Fig. 5.35 and is described below.

The marker generator is used in sweep mode to generate a marker pulse when the output frequency equals the frequency preset on a marker dial. The voltage outputs of the marker frequency control potentiometers are first buffered by voltage followers; M1 by half of IC1 and M2 by half of IC2. The marker voltage is then compared to the inverted sweep voltage. When the two voltages are equal in amplitude but opposite in sign, the comparator's output is zero volts.

A positive and negative comparison ramp is generated for each marker by IC3 and IC4. These ramps are summed by a full wave rectifier using germanium diodes. The output of this rectifier is a negative pulse with a width that is in constant relationship to the sweep voltage, so that the markers remain useful at very slow sweep rates. The marker pulse is shaped by schmidt triggers, part of IC5 and IC6, and then routed to the modulation mixer.

The 1 kHz square wave oscillator, IC9 and associated circuitry, generates a symmetrical square wave. The frequency is voltage controlled by a front panel control.

The amplitude modulation mixer, parts of IC6 and IC12, is a digital circuit that combines the markers, retrace blanking, and 1 kHz modulation into a single control signal.

The Sweep Trigger buffer,part of IC5, is used to develop a 60 Hz square wave for line triggering, and another is used to buffer an external square wave modulator.

The Cathode to Helix supply, (refer to Figure 5.35), is partially on Module A4, and partially in the BWO tube power supply section. It is configured as a high voltage output operational amplifier, with non-linear feedback to compensate for the voltage to frequency transfer relationship of the BWO tubes used with the unit.

The supply consists of several operational amplifiers on A4, a 4CX250B ceramic tetrode with associated power supplies and a feedback network assembly.

5.51 Analog Processor Board - A4 (Cont'd).

The frequency control signals and the ac and dc feedback signals are summed at the input of IC8. Q1 is used as a voltage amplifier to drive the control grid of V1, the high voltage pass tube. The dc feedback is derived through a voltage divider made from a 3 Meg. ohm resistor and a diode breakpoint linearizer. A voltage follower, half of IC7, drives the summing mode of the operational amplifier. An ac feedback loop is added in CW mode. This loop increases the ac gain of the feedback at the expense of high frequency response. The other half of IC7 is used as a voltage follower in this part of the feedback loop.

A "start" pot sets an offset voltage for the dc feedback loop and a "stop" or "end adjust" pot sets the gain. These pots are set so that the supply varies 550 to 2650 volts for a 0 to 5 volt change in input voltage.

5.52 Auxiliary Board - A5 (See Figure 7.5).

The auxiliary board, A5, Figure 7.5, includes: the leveling amplifier, the low pass filters, the LED driver, and the pen lift driver with relay. The operation of the leveling amplifier is described in Section 5.7.

The two lowpass filters are inserted into the input of the Cathode to Helix supply regulator. The output of one filter goes to the Cathode to Helix supply and the output of the second filter goes to the proportional sweep output BNC connector. These filters are used to restrict the frequency response of the Cathode to Helix supply to less than 20 kHz. This filtering effectively smooths the digitally generated sweep voltage at the higher sweep rates, and removes digital switching noise from the other circuits in the unit.

The LED driver buffers the status flags from the microcomputer for display on the front panel indicators.

The pen lift relay and driver operate during sweep retrace. The driver is turned on or off by switching the +12 V line at the rear panel.

5.6 General Interface Requirements (Also See Section 2.2).

The TTL level outputs "Blanking" and "Markers", will drive one TTL load. The TTL inputs "AM" and "Trigger", sink one TTL load.

The analog inputs, "Sweep" and "FM", are 10K input impedance. The analog outputs, "Sweep" and "Proportional Sweep", are nominally 100 ohm impedance, but will drive a 10K or greater load without impairing the system frequency control accuracy.

The short term stability required of the Cathode to Helix supply in CW mode also requires that the closed loop frequency response of this supply be low. This frequency response increases by opening up part of the feedback loop, when the supply is used in Delta-F and Sweep Modes.

The Cathode to Helix supply will sweep full band in CW mode, when driven from Ext. Sweep, in less than one mSec. A retrace time of 15 mSec. is required in this mode.

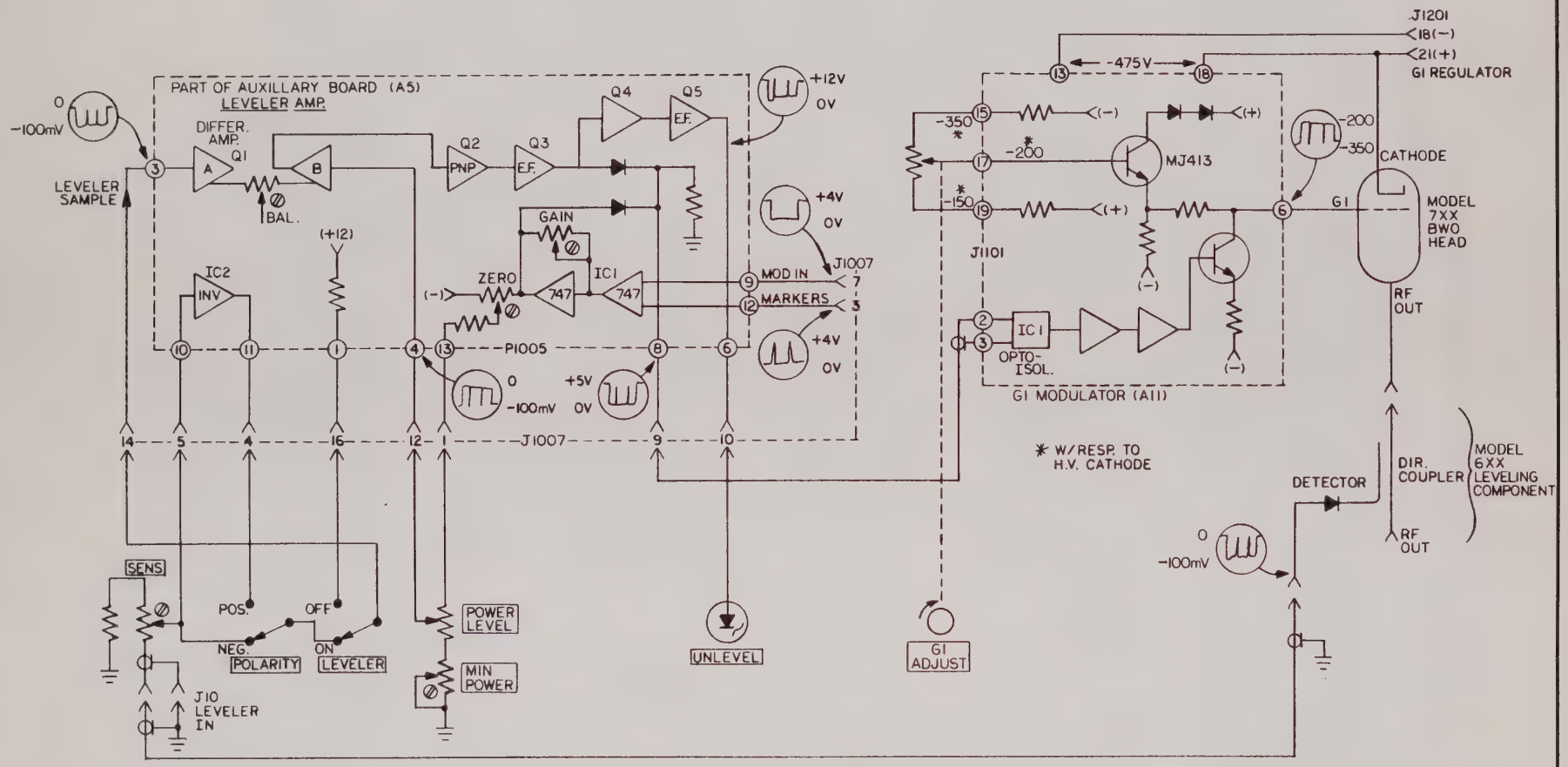
The AM modulation input is a digital input. A logic one turns the tube on, a logic 0 turns it off. The frequency response of this modulation chain is limited by the less than 10 uSec. rise and fall time of the G1 modulator.

5.7 Leveler Amplifier Operation.

GENERAL (See Fig. 5.7).

The leveler amplifier provides dc control signals which allow automatic power level control of the BWO. The unit develops this dc control voltage by comparing a sample of RF energy derived from a crystal diode detector, to an internal dc reference. The internal reference is taken from the AM modulator section of the Analog Processor.

If the voltage from the diode detector exceeds that of the dc reference, the leveler amplifier produces a signal indicating "excessive RF power". This voltage is fed to an opto-isolator within the Grid 1 modulator, and causes the G1 voltage to drop more negative, thus reducing the BWO output power. Power decreases until the diode detector voltage matches the internally set dc reference.



MICRO—NOW INSTRUMENT

SCALE NONE	REVISIONS: REVISED TO "C"	BY MRA	DATE 1/24/86
DATE 12/10/82			
DR'N MRA BBM			
APVD WLW			

TITLE: MODEL 705C LEVELING CIRCUIT - SIMPLIFIED SCHEMATIC

NO: FIG. 5.7

BROWNING #0-105

CIRCUIT OPERATION.

The internal reference voltages for square wave modulation and the markers which originate on the Analog Processor Board are applied to IC1. This operational amplifier is employed to set the TTL input signals such that the voltage applied to D4 is +5.6 volts for RF off, and 0 volts equals RF on. This voltage is divided and level shifted through R5, R7, and R8 so that the Power Level control is supplied with 0 volts for RF off and -300 millivolts for RF on.

Leveler signals from an external diode power detector or power meter are applied to J10. A portion of this voltage is taken from the sensitivity pot, and if of negative polarity, applied through the Crystal Polarity Switch (S10) and leveled switch (S11) to the differential amplifier Q1A. If positive polarity voltage is produced by the diode detector, IC2 is utilized to invert the sense of this voltage and S10 would be switched to the POSITIVE position.

Q1 differential amplifier compares the reference level input from the Power Level pot to the power detector output voltage from the Sensitivity pot. If the level applied to Q1A is more negative than that set by the Power Level pot, a condition of excessive RF power is indicated. Q1B conducts more heavily and the base of Q2 is pulled down from +12 volts, thus increasing its conduction. Q3 base voltage rises as a result, and its emitter current increases. The increased voltage produced is fed through D3 to R9 and then to the opto-isolator section of the Grid 1 Modulator. This positive going voltage then acts through the G1 modulator to increase the G1 potential (driving it more negative with respect to the BWO Cathode). The result is a decrease in RF power output. The RF power will drop until the differential amplifier Q1 is again balanced.

R15 balance control is provided to dynamically balance the leveler circuit when operating in the closed loop mode. It allows the circuit to be set so that square wave modulation operation provides no excessive spiking or oscillation in the system.

Q4 and Q5 are used to drive a front panel LED indicator. If the voltage from Q3 emitter increases, Q4 collector current increases and Q5 base drops toward ground. This causes a decrease in Q5 emitter current and as a result, the LED extinguishes indicating the system is leveled.

When S11 is switched to Unleveled, Q1A conducts heavily. The voltage at Q1B collector rises to +12 volts. Q2 is then cut off and Q3 base drive drops. This decreased voltage at Q4 base causes a decrease in its collector current so Q5 base rises. The resulting increase in Q5 emitter current then causes the Unleveled lamp to light.

SECTION 6 MAINTENANCE AND TROUBLESHOOTING

6.0 MAINTENANCE AND TROUBLESHOOTING:

6.1 Access to Interior.

- 6.11 Cabinet Removal.
- 6.12 Access to Power Supply and Microprocessor Sections.
- 6.13 Module Location.
- 6.14 Powering System While Open - Danger.

6.2 Periodic Maintenance.

6.3 Voltage Measurements.

6.4 Internal Adjustments.

6.5 Troubleshooting.

- 6.51 Tools Required.
- 6.52 Steps to Follow When Failure Occurs.
- 6.53 Use of Troubleshooting Tables.
- 6.54 Voltage and Waveform Measurements.
- 6.55 Special Precautions.

6.0 MAINTENANCE AND TROUBLESHOOTING:

6.1 Access to Interior.

6.11 Cabinet Removal - (See Figure 6.1).

The Model 705C is secured to the protective cabinet by four 1/4-20 bolts on the cabinet bottom, accessed through clearance holes near the four corners. Also, eight front panel fasteners on the left and right sides of the standard rack mount position must be removed.

Remove the line cord by unplugging it from the rear panel. Slide main unit out from the front.

6.12 Access to Power Supply and Microprocessor Sections.

Remove all top cover screws on left, right, rear and center. Lift off top cover. Both the left and right sides of the main unit are mounted with hinged angle brackets at their bottom. Removal of the five 6-32 screws towards the front and rear of the side panels will allow the sides to be swung open for easy access to the interior.

The Grid supplies are provided on circuit card modules which are mounted on the right side of the main cabinet. Access to these boards is made by folding down the right side of the unit.

The Cathode-Helix power supply high voltage section is located along the center divider panel and partially on the base plate. Control signals and the active portions of the regulation circuits are located on the Analog Processor board - A4.

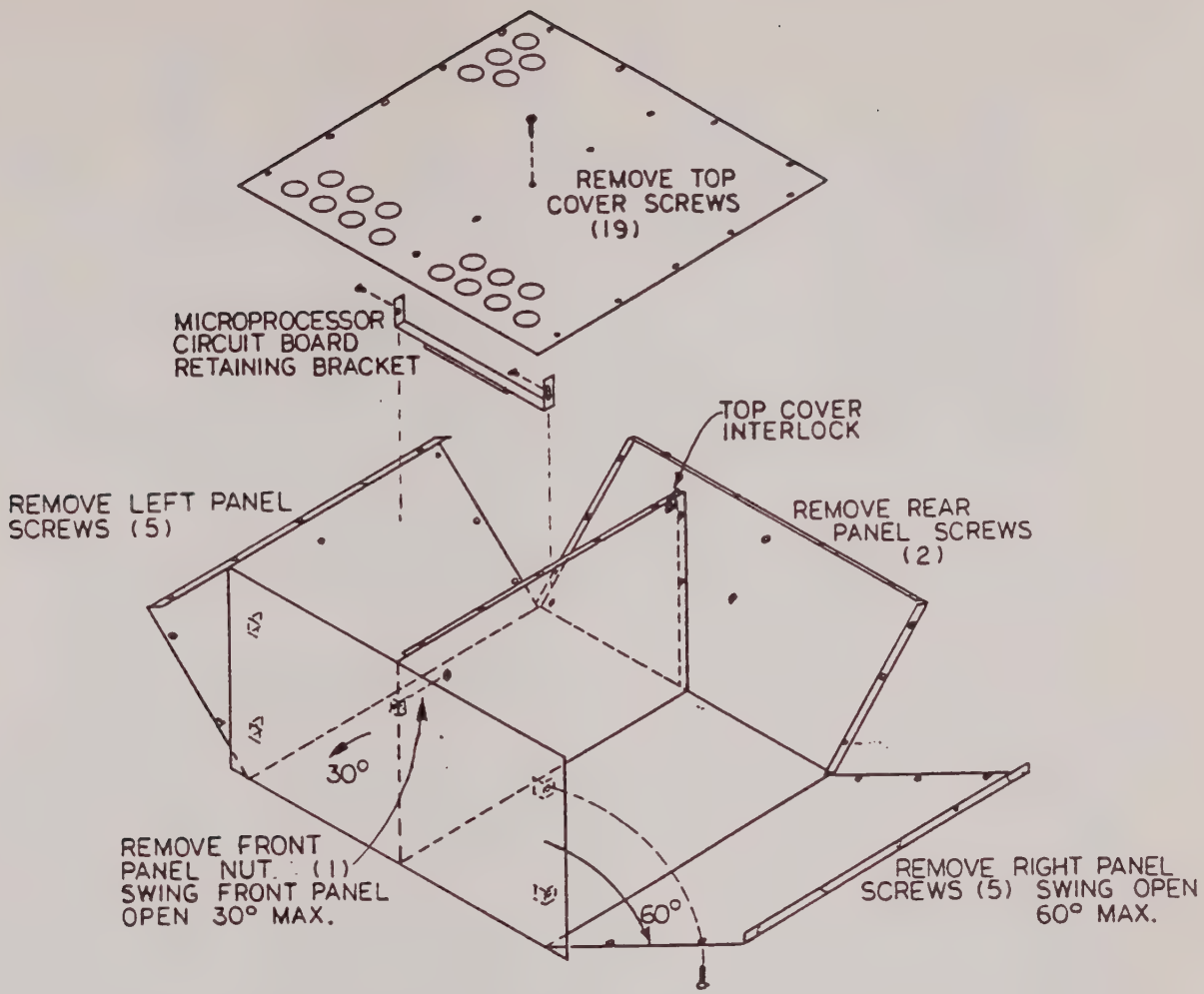
The BWO Heater Supply is also located on the base plate in the vicinity of the Cathode High Voltage supply rectifier circuit board. The constant current ballast regulating tube is nearby.

6.13 Module Location (See Figure 6.2).

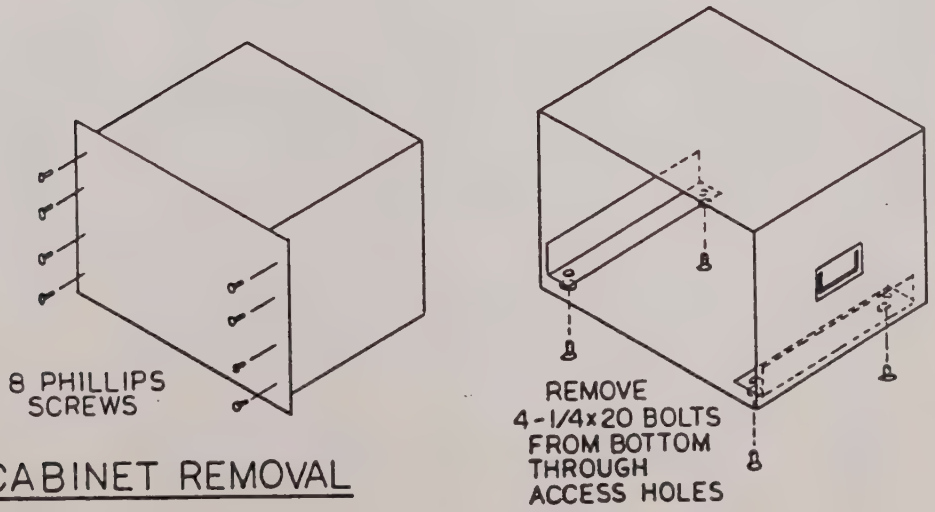
A module location diagram is given in Figure 6.2. Individual component layouts and schematic diagrams may be found in Section 7 of this manual.

6.14 Powering System While Open - Danger!!!

The entire right side of the system should be considered to be very hazardous as almost all circuitry is operating at the CATHODE high voltage potential. If power is to be applied, extreme caution should be taken to prevent electrical shock.

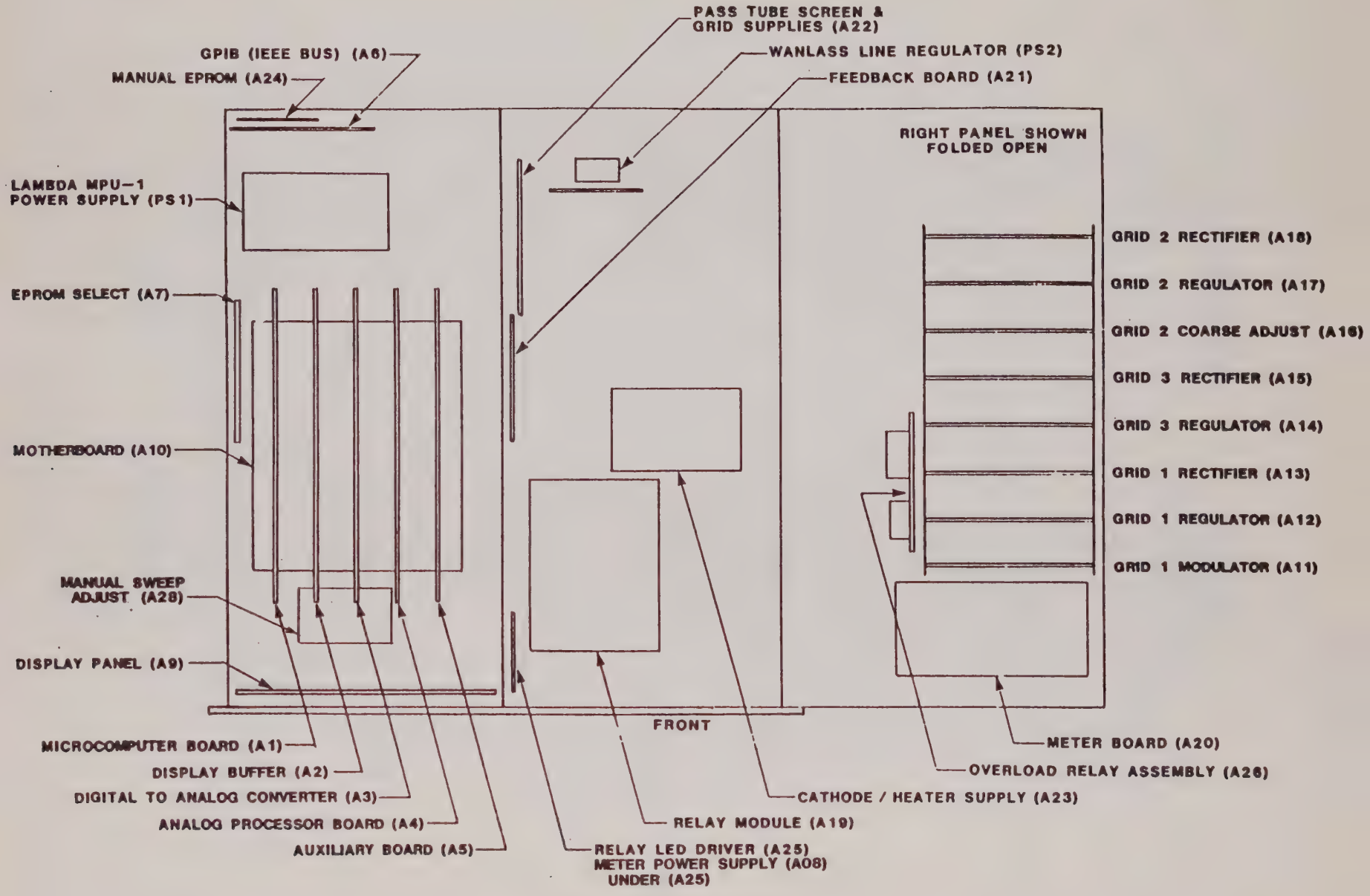

REMOVE TOP COVER SCREWS (19)
MICROPROCESSOR CIRCUIT BOARD RETAINING BRACKET
TOP COVER INTERLOCK
REMOVE LEFT PANEL SCREWS (5)
REMOVE REAR PANEL SCREWS (2)
30°
REMOVE FRONT PANEL NUT. (1) SWING FRONT PANEL OPEN 30° MAX.
60°
REMOVE RIGHT PANEL SCREWS (5) SWING OPEN 60° MAX.

EXPLODED VIEW-ACCESS TO SYSTEM



CABINET REMOVAL

FIGURE 6.1



MODULE LOCATION DIAGRAM

FIGURE 6.2

6.14 Powering System While Open - Danger (Cont'd).

To power the system on, the top cover interlock must be physically closed and a BWO head or dummy load connected to the main BWO Power Connector. For preliminary test purposes, a jumper wire may be placed between pins M and N on the 705C BWO connector to defeat the external interlock.

6.2 Periodic Maintenance.

Every few months perform the following maintenance on the Model 705C.

a) Remove all accumulated dust with forced air.

b) Check voltages as directed in Paragraph 6.3.

c) Make a performance test in accordance with the procedure in Section 2.

6.3 Voltage Measurements.

Measurement of the Cathode to Helix supply voltage generally satisfies the requirement of measuring the sweeper and pass tube supply voltages as these voltages contribute to the proper operation of the Cathode to Helix supply.

The Cathode to Helix supply may be programmed for one of three voltage ranges according to the placement of a jumper on the rear panel. The two ranges (for Siemens BWOs) are -550 volts to -2650 volts and -600 to -3000 volts , and -340 to -1685 volts for Varian BWOs. The -550 to -2650 volt range is calibrated at the factory and may be measured by a digital voltmeter with a high voltage probe. The test points for this and the other high voltage supplies are on the rear panel.

The G1, G2 and G3 supplies are referenced to the Cathode supply, not to ground. When these voltages are measured, the Cathode to Helix voltage should be set to its minimum for the range in effect, and a voltmeter with at least 1000 volts insulation to ground must be used. The typical range for G1 supply is 150 to 350 volts, for G2 the coarse range is 1000 to 3000 volts in 500 volt steps and the fine range is 500 volts on each coarse range, and for G3 the range is 170 to 420 volts. A 10% accuracy on these ranges is acceptable.

6.4 Internal Adjustments (See Figure 6.4).

The Model 705C has been designed with a minimum of internal adjustments. All adjustments are preset at the factory and except for the Cathode to Helix voltage, should not require periodic readjustment. A description of each adjustment and its location follows:

The G2 power supply includes an ac voltage pre-regulator. The RMS voltage output of this regulator is adjusted so that the voltage drop across the output regulator pass transistor in the G2 supply never exceeds 600 volts. This adjustment is performed at the factory and field readjustment is not advised.

There are three voltage adjustments in the microcomputer power supply. These voltages are set to 12.00, -12.00 and 5.00 volts.

The digital to analog converter module has an adjustment for the -5 volt reference voltage required by the converters.(R2 0-100% Pot located on the DAC Board.) This control is adjusted so that each frequency display shows its maximum value when there is less than 1/16 turn of over-rotation on any of the frequency controls.

There are three controls on the DAC board which calibrate the sweep and Delta-F multipliers. R3 adjusts the sweep scaling factor, R4 adjusts the Delta-F scaling factor, and R19 sets the Delta-F center to coincide with the frequency control setting.

Adjust Sweep Scaling Factor: Set the scaling factor pot, R3, fully CCW. Set the 705C for full band sweep; F1 at minimum, F2 at maximum. Set M1 at minimum and M2 at maximum. Using an oscilloscope in X-Y display mode, display the sweep out on X and the markers out on Y. Turn R3 clockwise until the high marker just disappears, then CCW until it reappears on the oscilloscope display.

Adjust the Delta-F center (R19); set this control so that the wiper to ground voltage is .625 volts.

Adjust the Delta-F scaling factor (R4): Begin by setting the F1 control so that the wiper to ground voltage is 2.500 volts. Turn the F2 control fully CCW, this sets the Delta-F width to 0. Monitor the sweep output SMA connector on the DAC Board with a DVM. Set the trigger mode to manual. Adjust R4 so that the voltage at the SMA connector is 2.500 volts.

INTERNAL ADJUSTMENTS

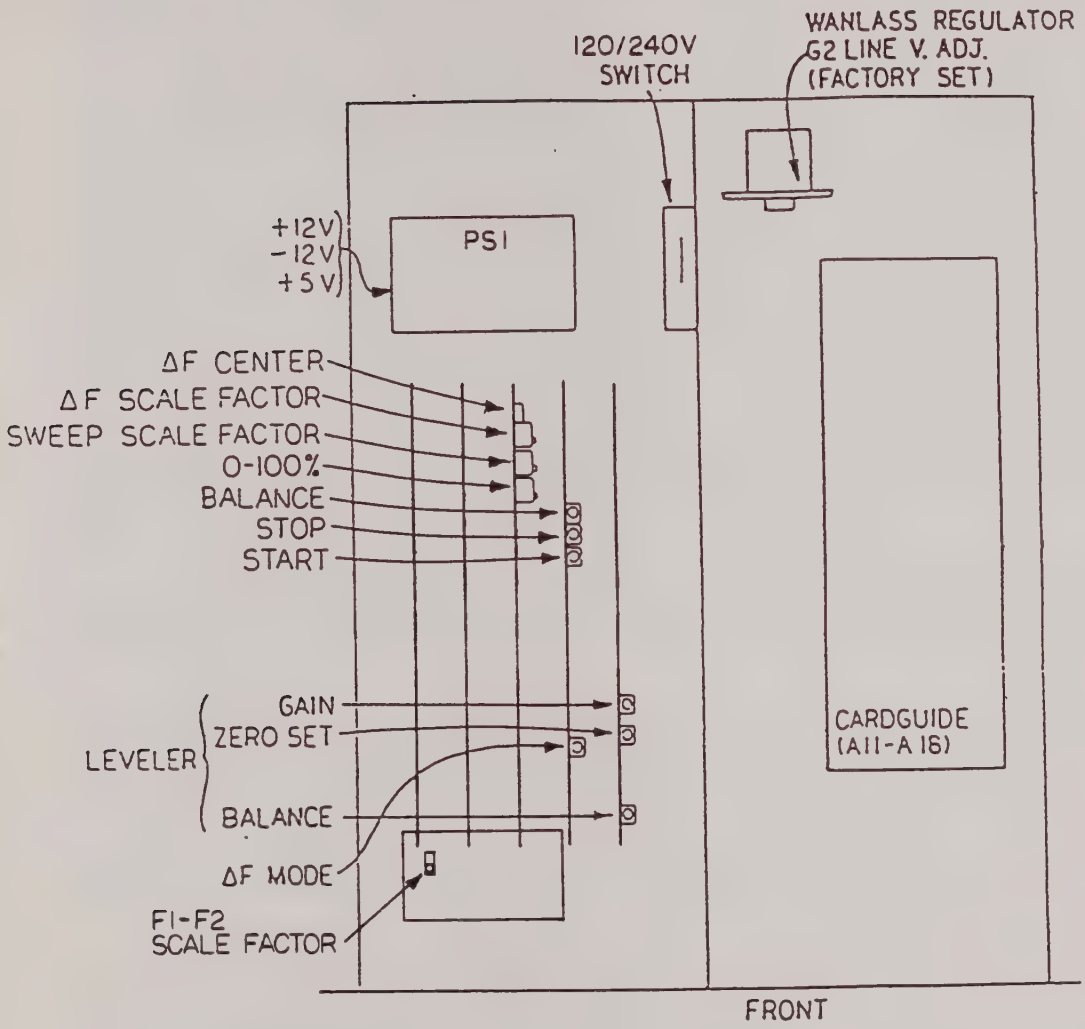


FIGURE 6.4

6.4 Internal Adjustments (Cont'd).

The analog processing module has four adjustments. One near the front of the board and three clustered together at the top rear. The adjustment near the front is no longer used. The remaining three adjustments on this board affect the Cathode to Helix supply operation. From front to back they are start or minimum voltage, stop or maximum voltage and balance.

The balance control has little effect, the wiper is set to zero volts, and it will not need to be readjusted. The start and stop controls are checked by setting the unit to CW mode and checking that the Cathode to Helix voltage, when the supply is jumpered for Range 2, is -550 volts at minimum frequency setting, and -2650 volts at maximum frequency setting. This voltage range determines the frequency calibration of the connected BWO and should be regularly checked and adjusted.

The auxiliary module has three controls which affect the operation of the Grid 1 Modulator. A complete discussion of these controls is given in Section 5.7. These contols are factory adjusted and should not require readjustment. These controls from front to back are: leveler balance, zero set, and gain.

This completes the description of the internal adjustments of the 705C unit.

6.5 Troubleshooting.

6.51 Tools Required.

Triggered Sweep Oscilloscope.
3-1/2 digit DVM and high voltage probe.
Logic Probe.
0 - 50 V Bench power supply.
RF hardware and detectors as appropriate for BWO tube in use.
A millimeter wave power meter, frequency counter, and spectrum analyzer will also be helpful.

6.52 Steps to Follow When Failure Occurs.

First check all voltages in accordance to Section 6.3 to help localize the trouble to a particular supply or other circuit. After making voltage measurements refer to the corresponding section of this manual to service the individual supply, if outputs are incorrect. If supplies are functioning properly, refer to the troubleshooting tables for further assistance.

Disconnect the BWO cable when servicing and troubleshooting the unit. The BWO head interlock may be defeated by shorting pins M and N on the BWO connector with a wire jumper.

To ease troubleshooting of the BWO Heater, G1, G2, and G3 supplies, the Cathode high voltage can be disabled. This will allow measurements to be made with respect to frame ground.

The Cathode to Helix supply may be disabled by unsoldering and insulating the high voltage lead to pin 13 of transformer T2 and then shorting the BWO Cathode supply to ground with a clip lead from TP4 to TP5 on the rear panel (see figure 7.30).

Caution! After trouble is cleared, make sure to remove the Cathode/ground short and re-connect pin 13 of T2.

6.53 Use of Troubleshooting Tables.

Tables are given which provide basic troubleshooting information. These tables are intended to give the experienced technician assistance in localizing performance faults to a specific section of the unit. After the fault is isolated reference must be made to the section of this manual that describes it in further detail.

TROUBLESHOOTING TABLES

TROUBLE INDICATION	PROBABLE CAUSE	REMEDY
1. MAIN POWER ON		
No main power.	Check outlet being used. Check power cord connected. Check F1 fuse.	Use active line outlet. Connect power cord. Change F1.
Main power Fuse F1 blows.	Short in AC primary control circuits.	Remove AC power, check for short circuit.
Main power Fuse F1 blows (220V line).	Internal switch set for 110V.	Change internal switch to 220V, change F1 value.
Main power on, DVM not illuminated.	Loose connections, DVM supply to DVM plug.	Check connectors are tight.
	Failure of DVM supply.	Check supply output. **DANGER! HV must be OFF.**
	Failure of DVM.	Contact factory for replacement.
Frequency displays not illuminated.	F4 microcomputer fuse open.	Replace F4.
	F4 blows at power on.	Short in Lambda supply output. Defective Lambda supply, replace.
	Loose connections.	Check cables, P201/P202 and P901/P902.
Frequency displays incorrect,	EPROM address from BWO Head wrong.	Review EPROM selection- Oper. Manual Sec. 2.14.
	EPROM in wrong socket.	Review EPROM selection- Oper. Manual Sec. 2.14.
Display changes with wrong control or all dials show same.	Analog to Digital converter defective.	Replace both 4016 ICs on DAC board, examine DAC waveshape in Analog to Digital converter.
Frequency displays show symbols or wrong numbers (BWO frequency tunes in CW but not in Sweep).	Microcomputer defect.	Use logic probe to trace signal flow.

TROUBLE INDICATION	PROBABLE CAUSE	REMEDY
2. H.V. ON		
Standby light does not energize after 120 seconds. Right side fan not running.	Fuse F2 blown.	Replace F2.
No standby light after 120 seconds (F2 okay).	Relay circuit failure.	Change K1 (26N0120). Check relay power supply.
Thermo/Interlock flashing.	Open interlock.	Top cover interlock open, BWO cable loose, BWO thermostat overheated.
H.V. ON - no high voltage.	Fuse F3 open.	Replace F3.
H.V. ON - no high voltage.	Fuse F3 blows.	Short or faulty component on T2 secondary - Check HV supplies for faulty rectifiers or filter capacitors.
H.V. ON- G1 too low -350/-450 with G1 full CCW.	AM Mod. at EXT. Sweep mode in manual. Leveler ON and misadjusted.	Switch AM MOD to OFF. Switch to CW. Turn level switch to unlevel. Readjust.
	Defective G1 Modulator.	Replace A11 board - Q2 (2N3439).
G3 does not cover normal range 170-420.	Defective G3 Regulator.	Replace A14-Q1 (MC1466L).
G3 voltage changes with time (gradual increase).	Defective G3 Regulator.	IC1 MC1466L, make R9 = 8.66 kohm.
G3 voltage changes with time (gradual decrease).	Defective G3 Regulator.	A14-Q1 leakage - replace with same type.

TROUBLE INDICATION	PROBABLE CAUSE	REMEDY
3. G2 HV ON		
G2 Ready or ON Lamps not lit.	Wanlass Regulator	Check Wanlass fuse, replace. Replace Wanlass regulator.
HV Overload at G2 ON.	Excessive G2 voltage causes HV overload.	Reduce G2 voltage. Reset overload switch.
	G1 set too low.	Set G1 to BWO data sheet. System in CW mode.
HV Overload at G2 ON (External Stabilizer being used).	Ext. Stabilizer cable HV breakdown, internal device failure.	Remove Ext. Stabilizer connections, replace Stabilizer jumper plug.
HV Overload G2 ON.	Defective BWO cable.	Check connectors for broken, open, or shorted wires.
HV Overload G2 ON.	Defective BWO.	Operate on dummy load, replace BWO.
4. HV ON, G2 ON		
G1 goes more negative as G2 voltage is raised.	System leveled mode.	Turn leveler off (Set to UNLEVEL).
No RF output, all voltages and Cathode current correct.	Defective power monitoring device.	Replace with known good power monitor, thermistor, or diode detector.
	Insufficient warm-up (G3 mistuned).	Adjust G3 +/- 50V about data sheet voltage. Reset as required during first 15-20 minutes of operation.
	BWO gassy, due to non-use.	Operate at reduced G2 voltage, reduced Cathode current (about 8 mA), and frequency at low end (550 V. cathode) in CW mode. Run for several hours to degas tube. In extreme cases, degassing may take several days if BWO has been non-operational for several months.

TROUBLE INDICATION	PROBABLE CAUSE	REMEDY
4. HV ON, G2 ON (CON'T)		
No RF output, all voltages and cathode current correct.	Magnetic field distorted due to ferrite isolator on BWO output flange.	Use at least a 4-5 inch straight section of waveguide to isolator, so magnetic field distortion effect is reduced.
	Defective BWO.	Substitute a known good BWO. Contact Micro-Now for help.
No RF frequency control (Cathode voltage does not change when tuned).	CW Mode switch in wrong position.	Check operating control positions.
CW Mode OK but unit will not sweep.	Fault in sweep generator.	Measure sweep output at DAC, deglitched output, Analog grid drive circuit.
5. BWO DETECTED RF POWER		
Excessive AM noise,	G3 mistuned.	Trim G3 for max. power out, minimum noise.
	BWO gassy.	(See above "BWO Gassy").
	G2, G1 mistuned.	Review control settings in CW mode.
	Defective BWO.	Substitute known good BWO.
Power output varies with sweep rate.	Normal at higher sweep rates.	Trim G3, reduce sweep rate.
Power output does not follow mfg. curve.	BWO grid settings.	Review control settings, trim G3.
	Defective power monitoring devices.	Most power monitoring devices are not flat across the entire waveguide band.
	Magnetic material too close to BWO output flange.	Use a straight waveguide section of 4-5" between BWO flange and isolators.

TROUBLE INDICATION	PROBABLE CAUSE	REMEDY
5. BWO DETECTED RF POWER (CON'T)		
Power "Holes."	Misaligned waveguide flanges.	Observe suspect waveguide part with a known, good broadband flat detector. Observe "holes" as waveguide flanges are loosened and tightened - adjust for flattest power output.
	Review mfg. data sheet, P.O. vs. Cathode V.	Some power "holes" are due to the nature of the BWO structure, especially at the low frequency end of the band. More apparent with higher frequency BWOs above 50 GHz.
6. LEVELING		
Leveling loop non-operating.	Check polarity switch.	Switch to correct polarity.
	Leveling detector no good.	Replace leveling detector.
	Leveling coax cable open or shorted.	Replace/repair coax cable.
	Sensitivity control misadjusted.	Review leveling operation.
	Auxiliary board misadjusted.	Review internal leveling adjustments.
7. FREQUENCY CALIBRATION		
Frequency calibration out of tolerance.	Dial/EPROM/BWO mismatch.	Match serial numbers on EPROM to BWO.
	Wrong Cathode to Helix voltage range.	Check and set correct range (rear panel).
	Cathode to Helix voltage range not calibrated.	On range 2 set Vmin to 550V, Vmax 2650V.
8. POWER OUTPUT		
Low power output.	Unexpected losses in connected hardware.	Remove or exchange coupling hardware.
	Wrong voltage settings for 733, 735, 736, or 737).	Consult BWO head instruction manual.

TROUBLE INDICATION	PROBABLE CAUSE	REMEDY
9. GPIB OPERATION		
GPIB malfunctions.	Controller failure.	Test controller functions on another instrument.
	Incorrect Bus address.	Set bus addresses "ON" for tune.
	Software error.	Use 705C test programs.

6.54 Voltage and Waveform Measurements.

Where applicable, voltage and waveform measurements are indicated on the schematics and block diagrams of the Model 705C circuits. These measurements can be used for troubleshooting within the circuits referenced. The conditions of measurement are indicated on each schematic.

6.55 Special Cautions.

Removal of PC boards. When a PC board extender is used for convenient access to a plug-in board, always turn the Power switch OFF before disconnecting the board from its socket and keep it off until the board is reconnected.

Qualified Service Personnel. The Model 705C contains high voltage circuitry which may present lethal hazards to service personnel. The Cathode to Helix supply and the other high voltage supplies present special hazards and are therefore interlocked with the unit's top cover. Service personnel unfamiliar and inexperienced with high voltage circuits should not attempt to defeat this interlock.

SECTION 7 SCHEMATICS AND DIAGRAMS

UNIT	TITLE	FIGURE NO.
A1	Microcomputer Board - Schematic	7.1
A1	Microcomputer Board - Parts Layout	7.1A
A2, A9	Display Buffer & Panel - Schematic	7.2
A2	Display Buffer - Layout	7.2A
A9	Display Panel - Layout	7.2B
A3	Digital to Analog Convertor - Schematic	7.3
A3	Digital to Analog Convertor - Layout	7.3A
A4	Analog Processor Board - Schematic	7.4
A4	Analog Processor Board - Layout	7.4A
A5	Auxiliary Board - Schematic	7.5
A5	Auxiliary Board - Layout	7.5A
A6	GPIB (IEEE Bus) - Schematic	7.6
A6	GPIB (IEEE Bus) - Parts Layout	7.6A
A7, 24	EPROM Select & Manual EPROM - Schematic & Layout	7.7
A8	DVM Power Supply Board - Schematic & Layout	7.8
A10	Mother Board - Wiring Diagram	7.10
A11-13	Grid 1 Power Supply & Modulator - Schematic	7.11
A11	Grid 1 Modulator - Parts Layout	7.11A
A12	Grid 1 Regulator - Parts Layout	7.12
A13	Grid 1 Rectifier - Parts Layout	7.13
A16-18	Grid 2 Power Supply - Schematic	7.14
A16	Grid 2 Coarse Adjust - Layout	7.15
A17	Grid 2 Regulator - Layout	7.16
A18	Grid 2 Rectifier - Layout	7.17
A14, 15	Grid 3 Power Supply - Schematic	7.19
A14	Grid 3 Regulator - Layout	7.20
A15	Grid 3 Rectifier - Layout	7.21
A11-18	Card Guide Assembly Wiring	7.22
A23	BWO Heater Supply	7.23
A23	Cathode/Heater Supply - Layout	7.23A
A19	Relay Module - Schematic	7.24
A19	Relay Module - Layout	7.24A
A25	Relay LED Driver - Schematic	7.25
A25	Relay LED Driver - Layout	7.25A
A26	Overload Relay Assembly - Layout	7.26
PS1	Lambda Power Supply LOT-X-5152-A - Schematic	7.27
A20	Meter Board Layout	7.28
A21	Feedback Board - Layout	7.29
---	AC Power Distribution & Relay Operation	7.30
A22	Pass Tube Screen & Grid Supplies - Layout	7.31
PS2	Wanlass Line Regulator - Schematic	7.32
---	BWO Dummy Load Connections	7.33
A27	Manual F1-F2 Board - Schematic & Layout	7.34

✱EPROM SELECT JUMPERS

JUMPER (FOIL)	EPROM
1	2708
2	2716
3	4118

NOTE 2:
S/N 2280 AND LOWER — 2708
S/N 2281 TO 2381 — 2716
S/N 2470 AND UP-HN462732G

J101 (NOTE 2)
MATES WITH J703 ON SELECT BOARD

IC11 4801A 0000
IC10 4801A A000
IC9 705CR4 C000 (NOTE 2)
IC8 GPIBR1 E000 (NOTE 2)

IC14 74LS138
PIN6 IC2

IC1 74LS244
IC7 74LS244
IC6 68A00

IC2,3 - {PIN 14 IS +5V / PIN 7 IS GND
IC2,IC3 - 74LS37

IC5 74LS242
IC4 74LS242

P1001

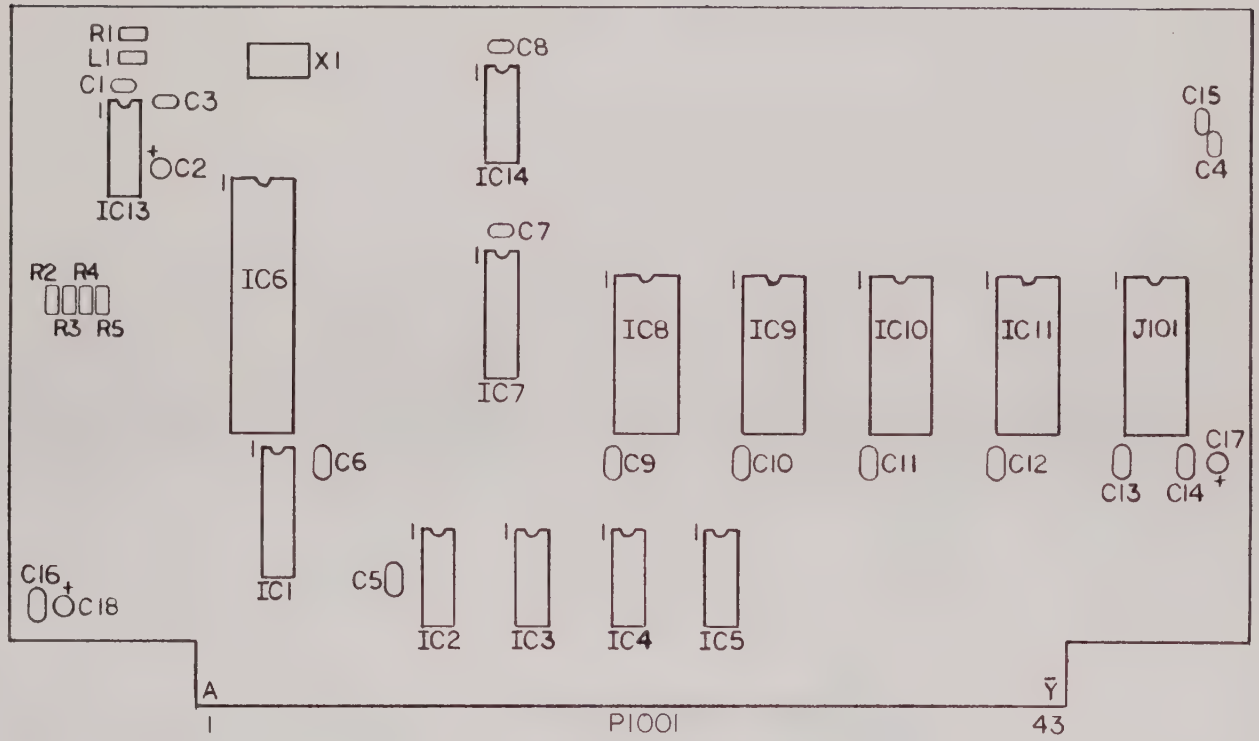
IC13 6875
6.8uH L1, 1K R1, 100pF C1, X1 6MHz, + C2 22uF 16V

R2,R4 - 3.3K
R3,R5 - 10K

NOTE 1:
C3-16 - .1uF, 50V, MONO.

MICRO-NOW INSTRUMENT		
SCALE: NONE	APPROVED BY: BBW [illegible]	DRAWN BY MRH
DATE: 11-10-82		REVISED
EPROM SELECT JUMPERS (S/N 2281 & UP) ECN 705115 DELETE R6, D1 " " REVISE TO "C" " 705124		MRA 3/3/83 " 3/7/83 MRA 3/4/86
MODEL 705C MICROCOMPUTER BOARD (A1)		DRAWING NUMBER FIG. 7.1

17223 PRINTED ON NO. 1000H CLEARPRINT



MICRO—NOW INSTRUMENT

SCALE N/A	REVISIONS	BY	DATE
DATE 10-29-82	DELETE R6, D1, C19	RJ	8/30/83
DR'N MRA CKD	REVISE TO "C"	MRA	12/14/85
AP VD			

TITLE: MODEL 705C MICROCOMPUTER BOARD PARTS LAYOUT (A1)

NO: FIG. 7.1A

BRUNING 40-105

F1 M1 M2 F2

DS1 DS2 DS3 DS4 DS5 DS6 DS7 DS8 DS9 DS10 DS11 DS12 DS13 DS14 DS15 DS16

A9

J901 P901 J902 P902

J201 P201

J202 P202

A2

TRK/HLD
VCC +5V
GND
Ø2
RESET
R/W
P1002
A1
AØ
D7 D6 D5 D4 D3 D2 D1 DØ
A15 A14 A13 A12 A11 A1Ø A9 A8 A7 A3 A2 A6 A5 A4
P1002

L1 1mH L2 1mH
C1 100µF C7 4700µF C6 4700µF C2 C3 C4 C5 4 x .1µF

IC3 68A21 PIA
IRQA IRQB EN RST R/W CSØ CS1 CS2 A1 AØ D7 D6 D5 D4 D3 D2 D1 DØ
CA1 CA2 PAØ PA1 PA2 PA3 PA4 PA5 PA6 PA7 PBØ PB1 PB2 PB3 PB4 PB5 PB6 PB7 CB1 CB2

P1002
D3 D2 D1 DØ

IC4 74LS24Ø
IC5 74LS138
IC6 LS32
IC7 LS27
IC8 74LS138
IC9 74LS148

IC1 IC2 ICM7218C
+V DP HEX GND IDØ ID1 ID2 ID3 W DAØ DA1 DA2 DS SEG

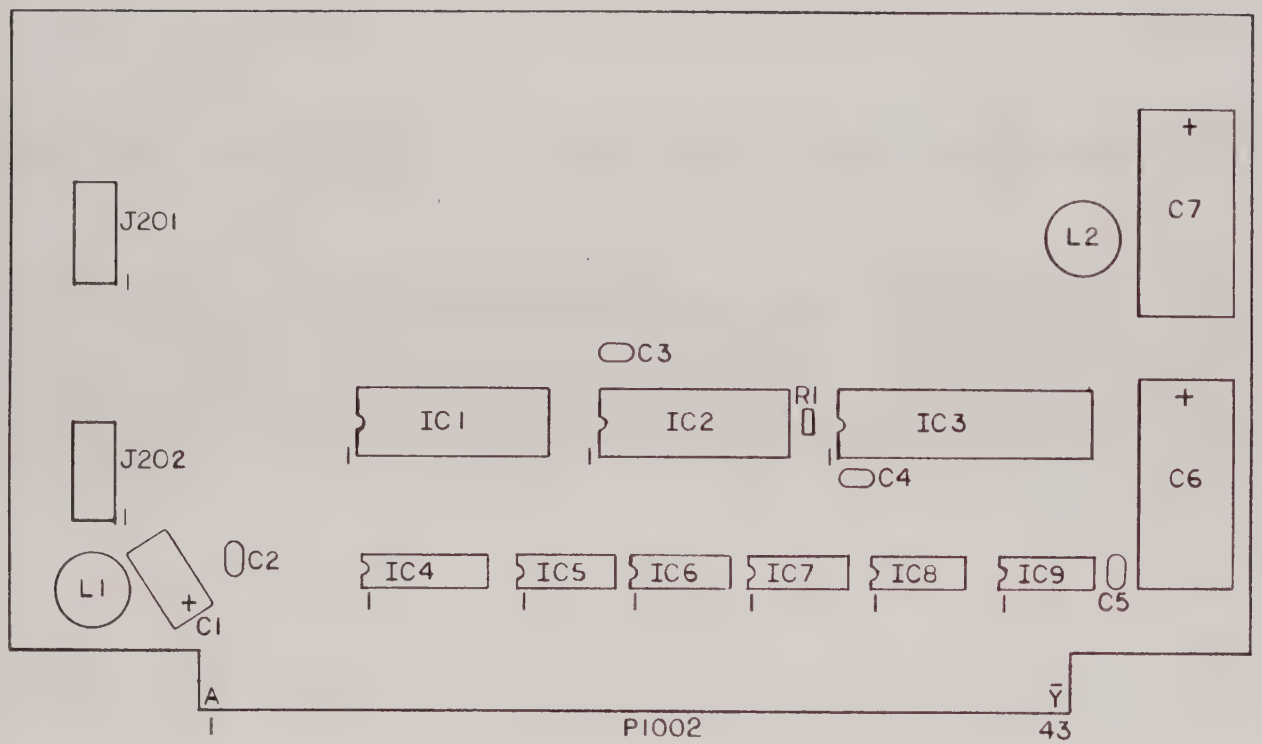
MICRO-NOW INSTRUMENT

SCALE: NONE	APPROVED BY BBM WRJ	DRAWN BY MKH	
DATE: 8/4/82		REVISED 3/4/86	

MODEL 705C DISPLAY BUFFER (A2) AND PANEL (A9)

DRAWING NUMBER FIG. 7.2

18384 PRINTED ON NO. 1000H 8 CLEARPRINT FADE-OUT



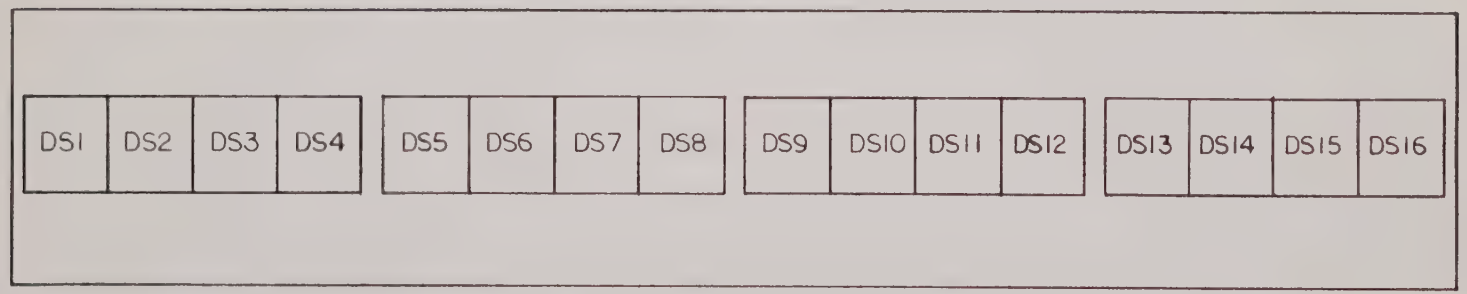
MICRO—NOW INSTRUMENT

SCALE N/A	REVISE TO "C"	BY MKA	DATE 12/11/85
DATE 11/1/82			
DR'N MKA CK'D			
AP'VD			

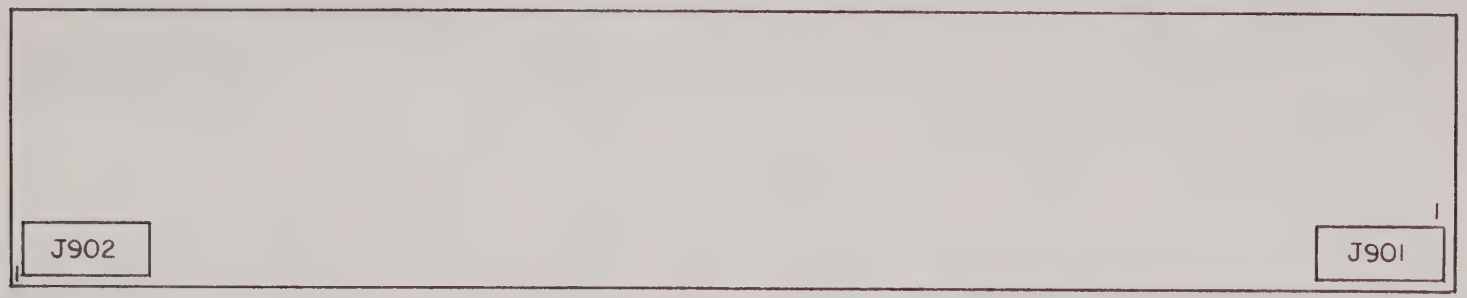
TITLE: MODEL 705C DISPLAY BUFFER BOARD PARTS LAYOUT (A2)

NO: FIG. 7.2A

BRUNING 40-105



COMPONENT OR FRONT VIEW



REAR VIEW

MICRO—NOW INSTRUMENT

SCALE N/A	REVISE TO "C" (REVISIONS)	BY MRA	DATE 12/11/85
DATE 11/1/82			
DR'N MRA CKD			
APP'VD			

TITLE: MODEL 705C DISPLAY PANEL BOARD PARTS LAYOUT (A9)

NO: FIG. 7.2B

BRUNING 40-105

IC1,2-4026
IC1: PIN 7-GND
PIN 16-+5v
IC2: PIN 5,6,7-GND
PIN 16-+5v

IC4-7404
IC4: PIN 7-GND
PIN 16-+5v

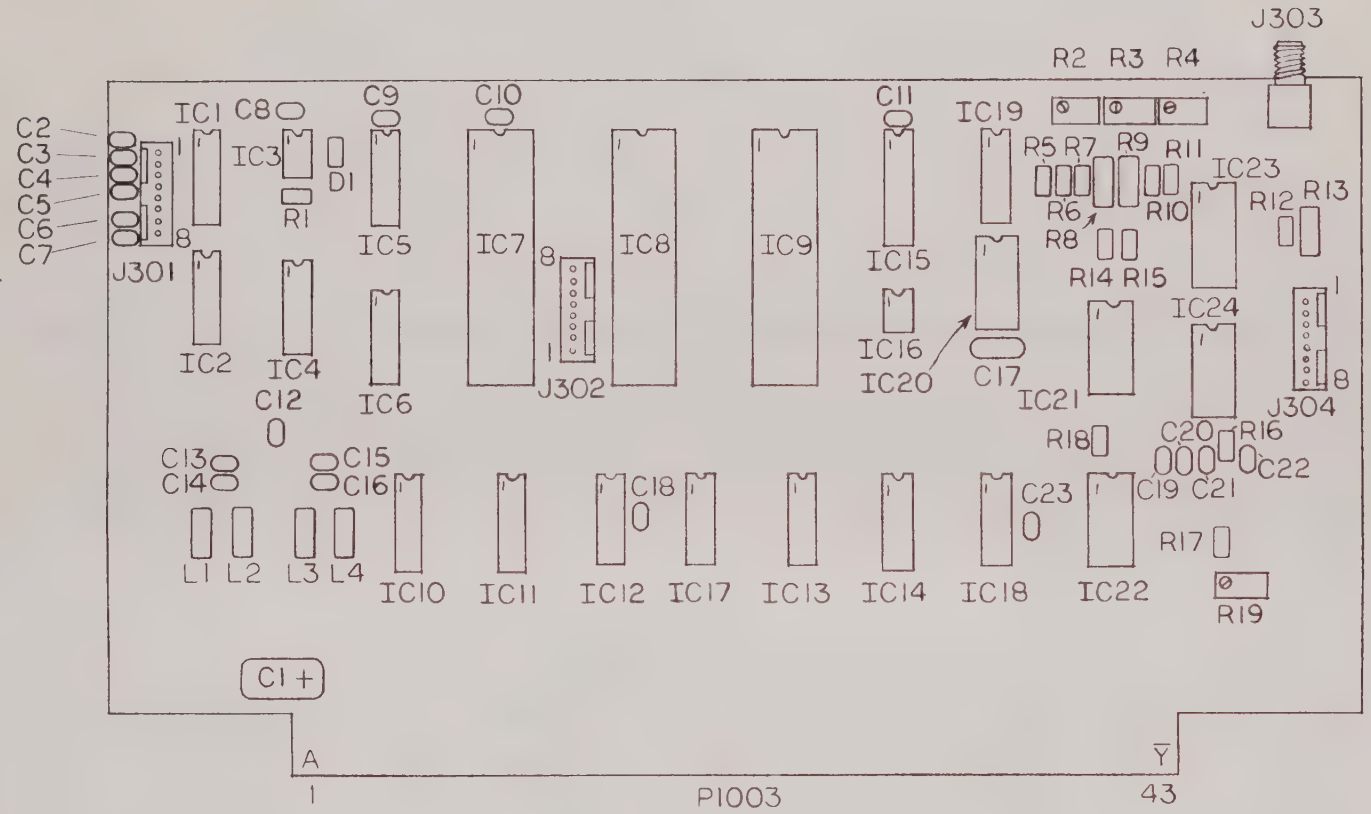
IC12,13-7404
IC12,13 PIN 14-+5v
PIN 7-GND

IC18-7400
IC18 PIN 14-+5v
PIN 5,7-GND

NOTE: ALL RESISTANCES IN OHMS AND 1/4W, 5% UNLESS OTHERWISE NOTED. ALSO ALL CAPACITANCES IN MICROFARADS UNLESS OTHERWISE NOTED.

MICRO-NOW INSTRUMENT		
SCALE: —	APPROVED BY:	DRAWN BY S.K.C.
DATE: 7-3-85		REVISED
MODEL 705C DIGITAL TO ANALOG CONVERTOR BOARD (A3)		DRAWING NUMBER FIG 7.3

18224 PRINTED ON NO 1000H CLEARPRINT



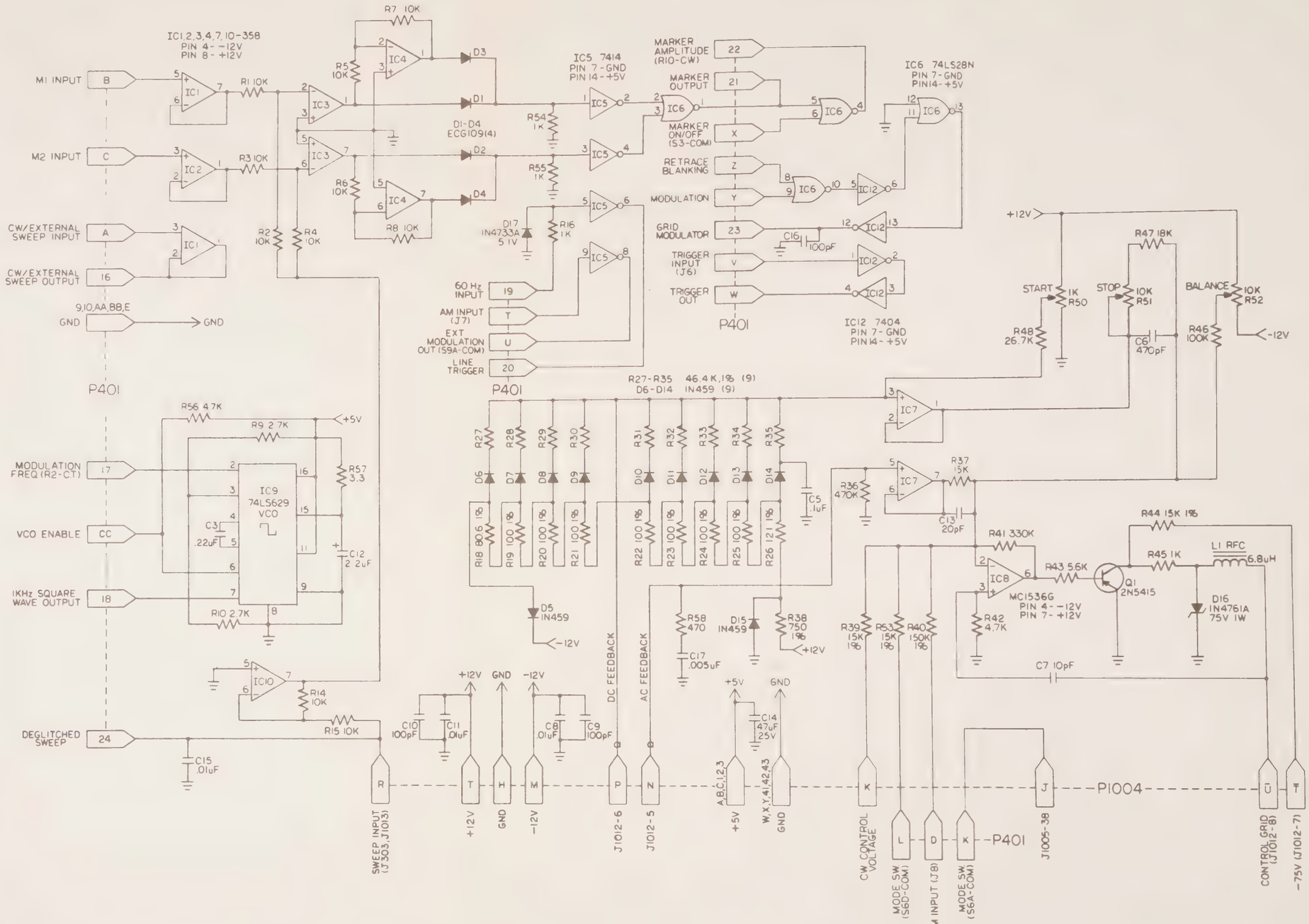
MICRO—NOW INSTRUMENT

SCALE N/A	REVISIONS	BY	DATE
DATE 6-20-85			
DR'N A.V.S. CKD			
AP'VD			

TITLE: MODEL 705C DAC BOARD PARTS LAYOUT (A3)

NO.: FIG. 7.3A

BRUNING 40-105



ALL RESISTANCES IN OHMS.

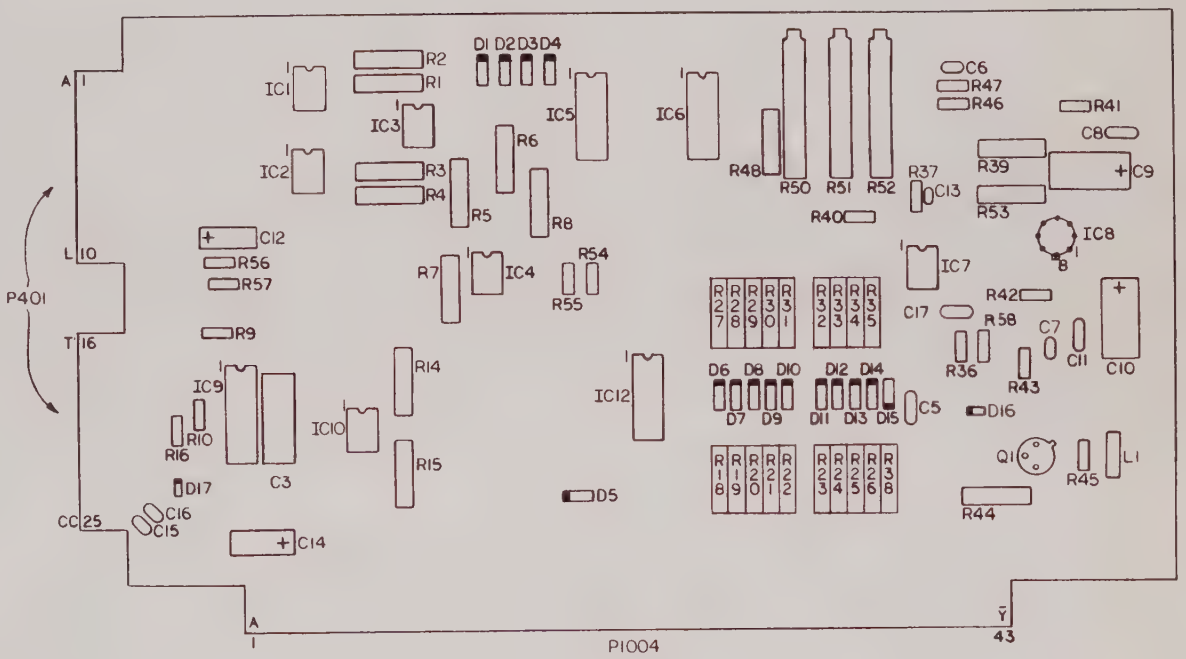
BRUNING 40-105

MICRO-NOW INSTRUMENT

SCALE N/A	REVISIONS	BY	DATE
DATE 4/10/86			
DR'N I CK'D			
AP'VD			

TITLE MODEL 705C ANALOG PROCESSOR BOARD (A4)

NO FIG. 7.4



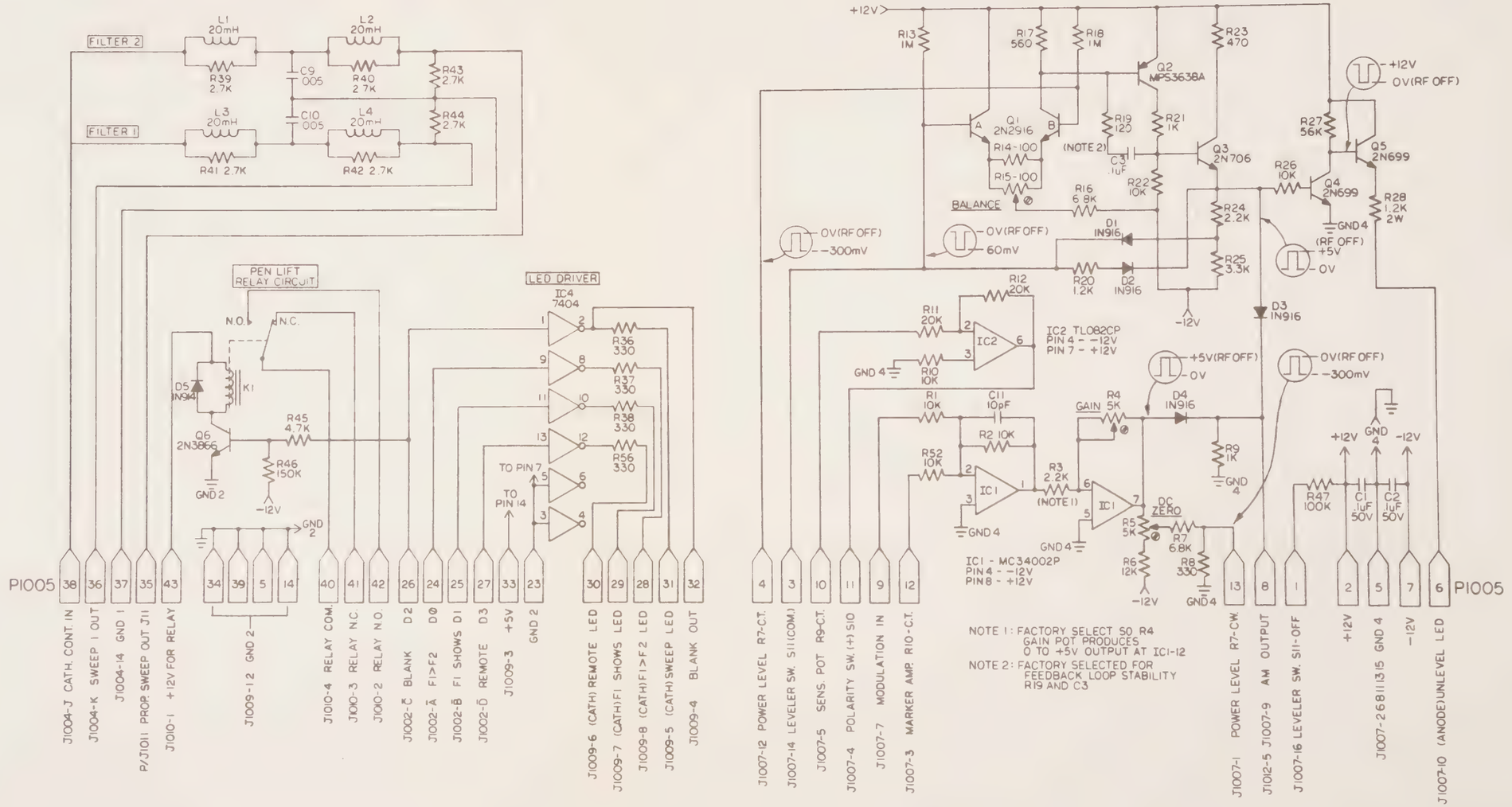
MICRO—NOW INSTRUMENT

SCALE N/A	REVISIONS	BY	DATE
DATE 11-29-82	ADD C17 AND R58 ECN 705125	RJ	9/2/83
DR'N MKA CKD EBM	REVISE TO "C"	MKA	12/11/85
AP'VD			

TITLE MODEL 705C ANALOG BOARD PARTS LAYOUT (A4)

NO FIG. 7.4A

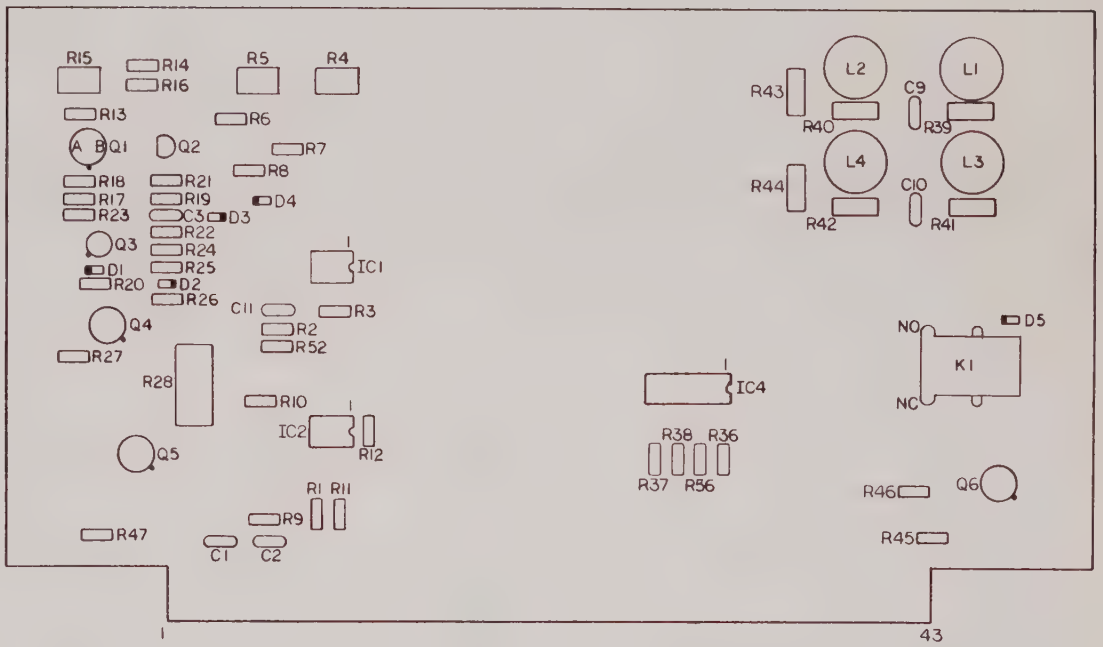
BRUNING 40-105



BRUNING #0-105

MICRO-NOW INSTRUMENT

SCALE N/A	REVISIONS	BY	DATE
DATE 4/17/86			
DR'N MRA CHD			
APVD			
TITLE MODEL 705C AUXILIARY BOARD (A5)	NO FIG. 7.5		



MICRO—NOW INSTRUMENT

SCALE N/A	REVISIONS R32·R33 NOTE ECN 705112	BY MRA	DATE 12/10/82
DATE 11-30-82	ADD IC5, R57, R58, C12 ECN 705124	RJ	4/2/83
DR'N MRA CHK BBM	ADD C11 ECN 705123	RJ	3/9/84
AP'VD MRA	REVISE TO "C"	MRA	12/11/85

TITLE MODEL 705C AUXILLARY BOARD PARTS LAYOUT (A5)

NO FIG. 7.5A

BRUNING 40-105

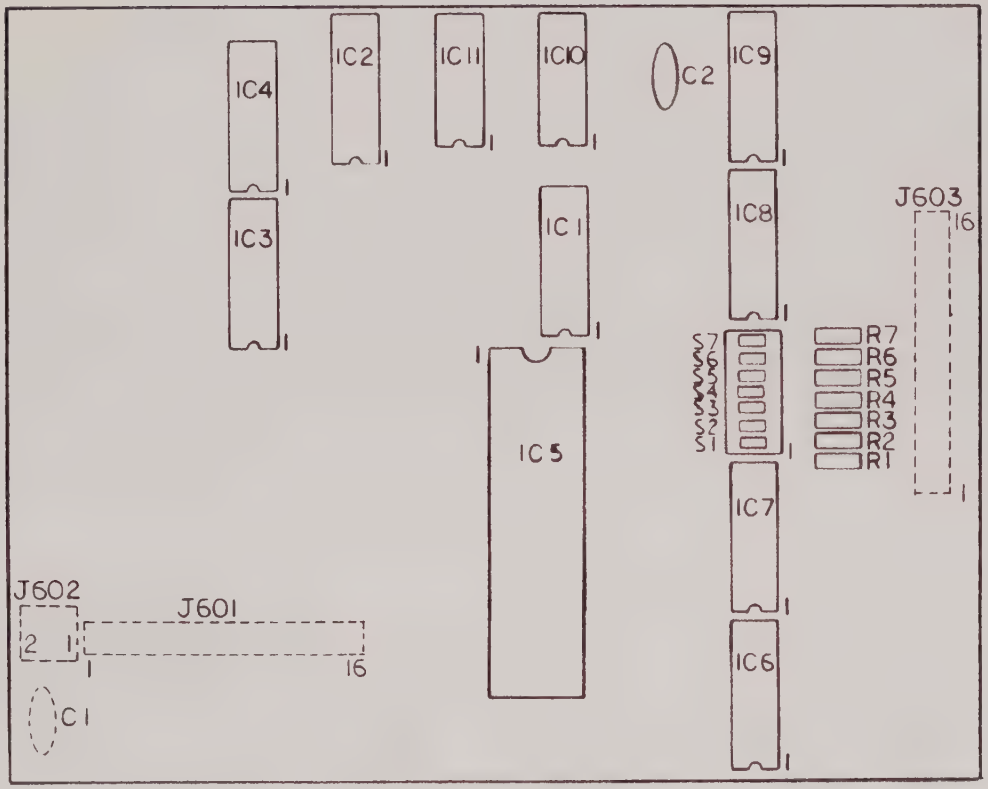
S1
S2
S3
S4
S5
S6
S7
S1-7 SWITCH DIP
7 - 3.9KΩ R1 R2 R3 R4 R5 R6 R7
R1-R7
+5v
MC8T97 IC1 TRI-STATE BUFFER
8T26 INVERTING BUFFER IC3
8T26 INVERTING BUFFER IC4
IC10
IC11
7400
MC3448A IC6
MC3448A IC7
MC3448A IC8
MC3448A IC9
MC68488 GPIA IC5
MC8T97 IC2 TRI-STATE BUFFER
IC00
IC10
7404 INVERTER PIN 14 +5v PIN 7,11,13 GND
12,18,19, 20,21,22 23,24 ARE GNDS.
J601 P601
J1006 P1006
MICROCOMPUTER BUS
J603 P603
J12 GPIB
AMPHENOL CONNECTOR
EOI
SRQ
REN
IFC
ATN
NDAC
NRFD
DAV
DI
D2
D3
D4
D5
D6
D7
D8
R/W
IRQ
27/3
RESET
Φ2
A2
A1
AØ
J602
IC1-IC9
PIN 14-IC10
C1 .1uF
C2 .01uF
GND

BRUNING 40-105

M.C. NOW INSTRUMENT CO.
5104 N. PULASKI ROAD
CHICAGO, ILLINOIS 60646

SCALE	NTS	REVISIONS	BY	DATE
DATE	6/17/81	REVISE TO "C"	MRA	7/15/86
DR'N	MF			
APVD	WRD			

TITLE: MODEL 705C GPIB (IEEE BUS) BOARD (A6)
NO: FIG. 7.6



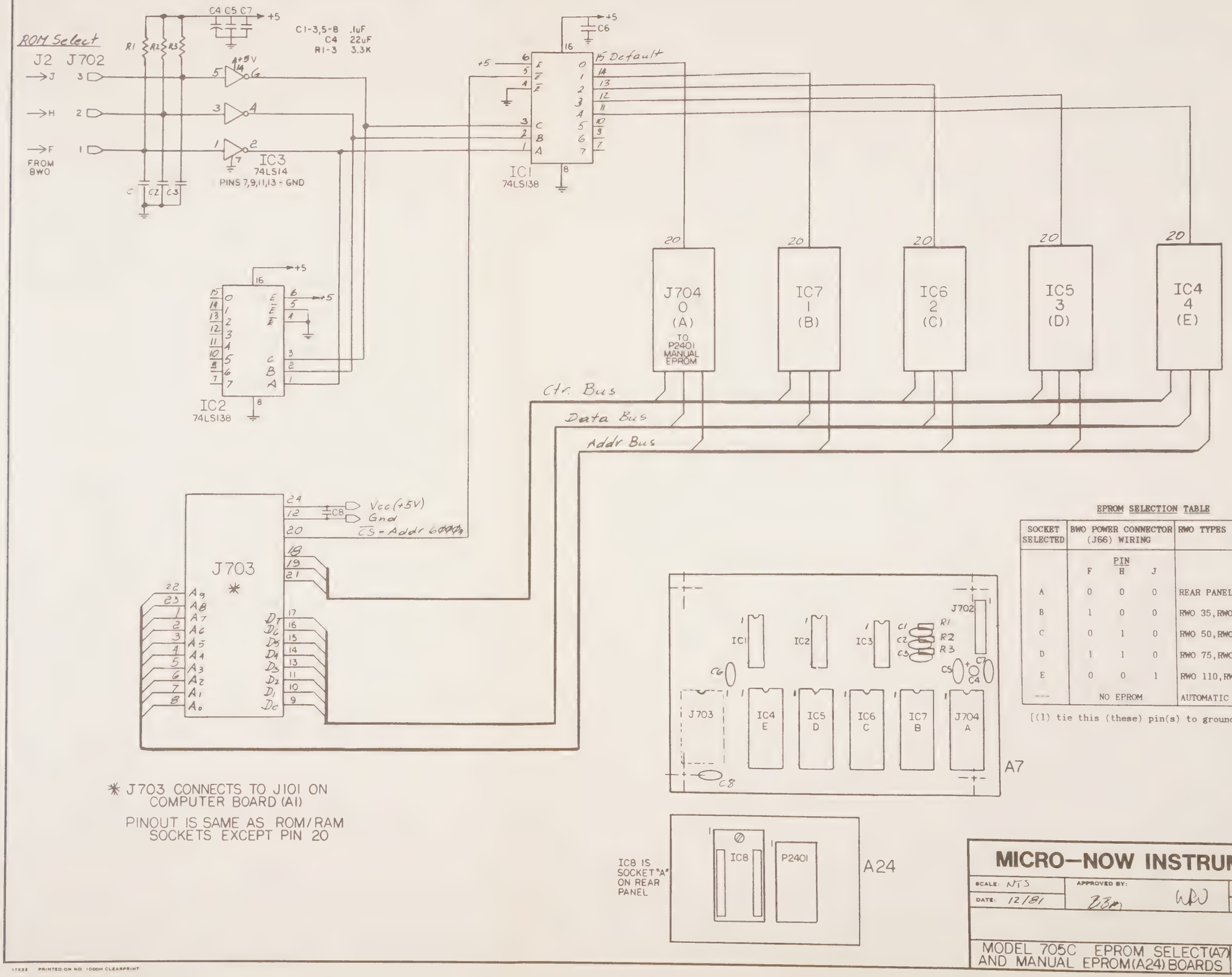
MICRO—NOW INSTRUMENT

SCALE N/A	REVISE TO "C"	BY MRA	DATE 12/11/85
DATE 10-26-82			
DR'N MRA CKD			
APP'VD			

TITLE: MODEL 705C GPIB (IEEE BUS) BOARD PARTS LAYOUT (A6)

NO. FIG. 7.6A

BRUNING 40-105



* J703 CONNECTS TO J101 ON COMPUTER BOARD (A1)

PINOUT IS SAME AS ROM/RAM SOCKETS EXCEPT PIN 20

EPROM SELECTION TABLE

SOCKET SELECTED	BW0 POWER CONNECTOR (J66) WIRING PIN F	PIN H	PIN J	RW0 TYPES (SUGGESTED)
A	0	0	0	REAR PANEL, ANY RW0
B	1	0	0	RW0 35, RW0 50
C	0	1	0	RW0 50, RW0 60, RW0 75
D	1	1	0	RW0 75, RW0 80, RW0 110
E	0	0	1	RW0 110, RW0 170
---	NO EPROM			AUTOMATIC 0-100%

[(1) tie this (these) pin(s) to ground, pin K]

IC8 IS SOCKET "A" ON REAR PANEL

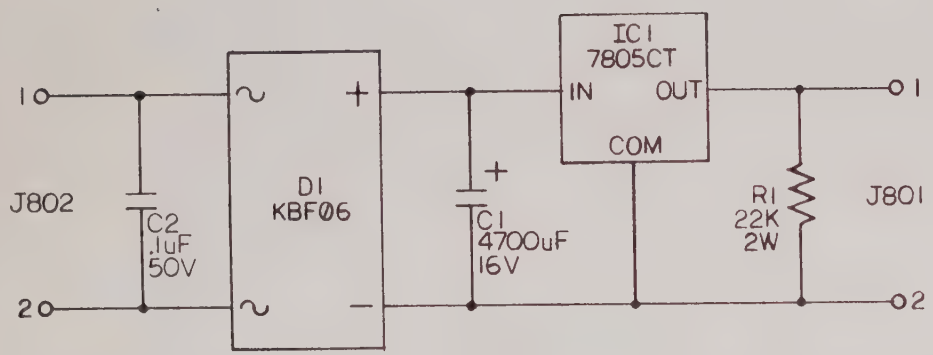
MICRO-NOW INSTRUMENT

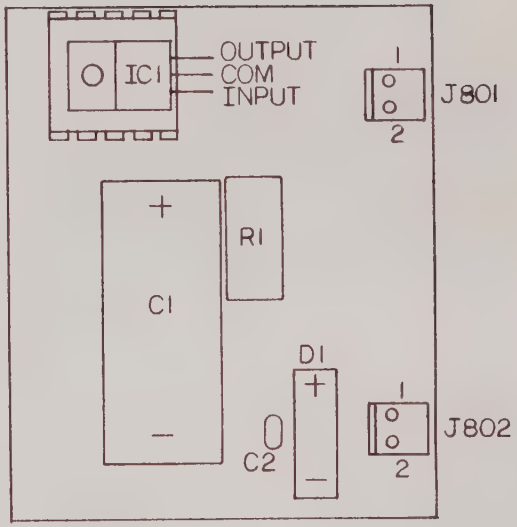
SCALE: NTS	APPROVED BY:	DRAWN BY MRH
DATE: 12/81		REVISED 4/2/86 MRH TO-6

MODEL 705C EPROM SELECT(A7) AND MANUAL EPROM(A24) BOARDS

DRAWING NUMBER FIG. 7.7

17X22 PRINTED ON NO. 1000H CLEARPRINT





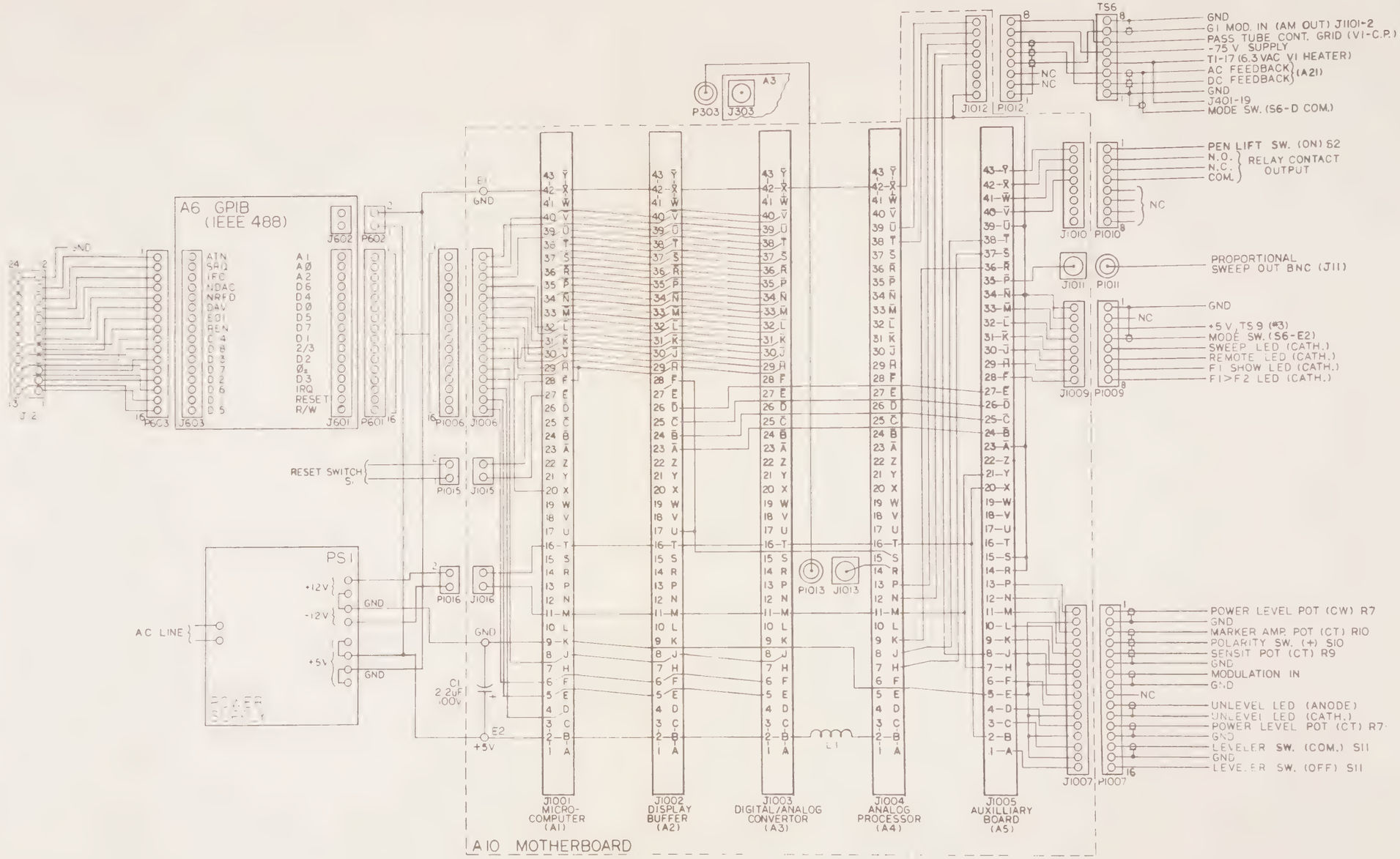
MICRO-NOW INSTRUMENT

SCALE N/A	REVISIONS	BY	DATE
DATE 4/2/86			
DR'N. MRA CKD			
AP'VD			

TITLE MODEL 705C
DVM POWER SUPPLY BOARD (A8)

NO. FIG. 7.8

BRUNING 40-105



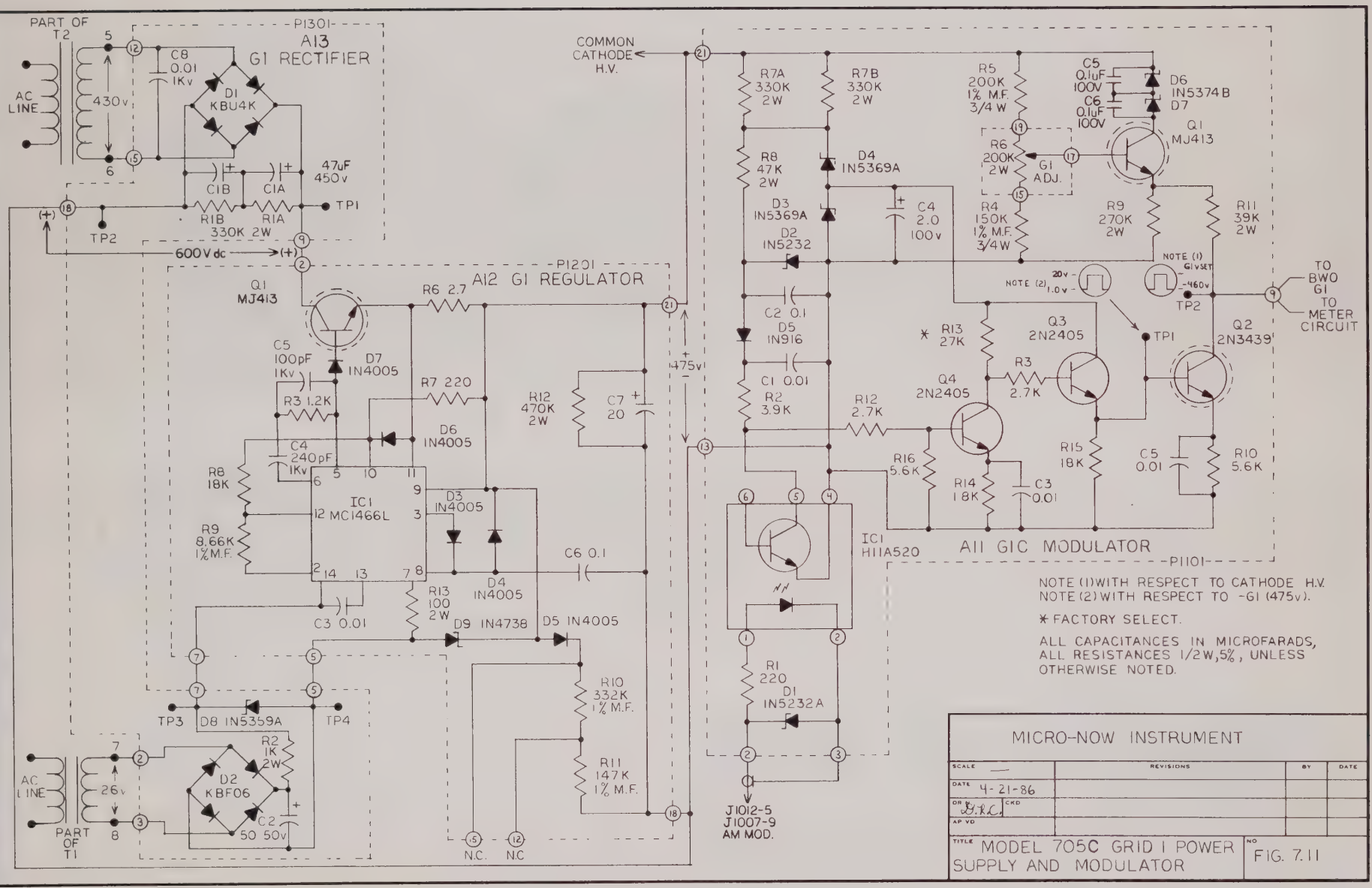
MICRO-NOW INSTRUMENT

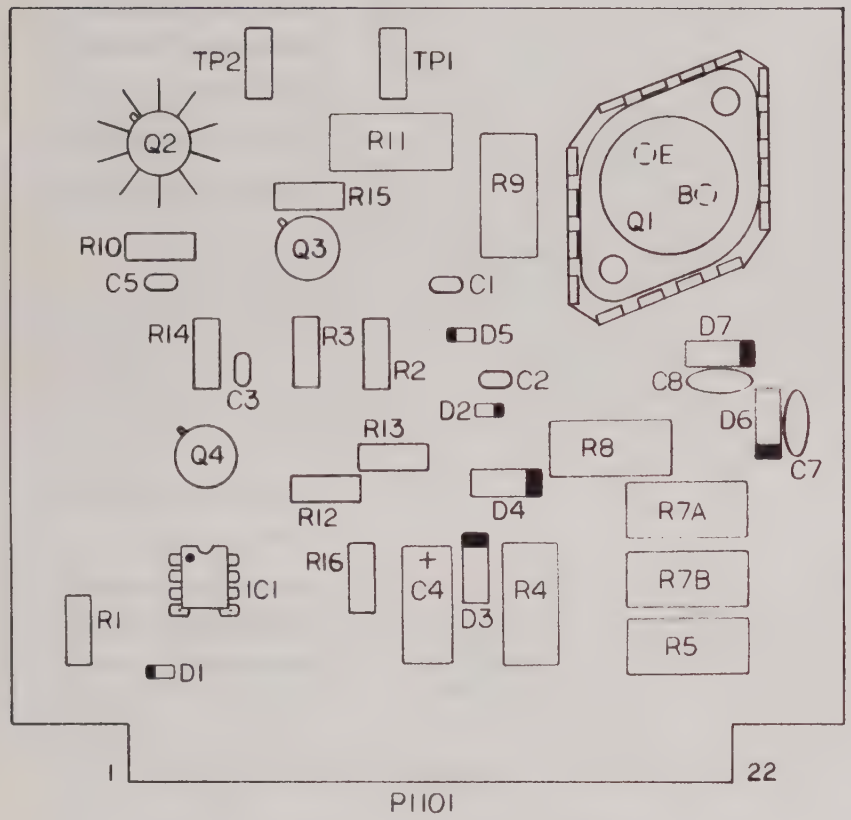
SCALE: —	APPROVED BY:	DRAWN BY MRH
DATE 9/14/82	MW	REVISED TO C 4/3/86

MODEL 705 C
MOTHERBOARD (A10)

DRAWING NUMBER
FIG. 7.10

18224 PRINTED ON NO. 1000H CLEARPRINT


PART OF T2
AC LINE
430v
P1301
A13 G1 RECTIFIER
C8 0.01 1Kv
D1 KBU4K
C1B
C1A
47uF 450v
R1B
R1A
330K 2W
TP1
TP2
600V dc
P1201
A12 G1 REGULATOR
Q1 MJ413
R6 2.7
C5 100pF 1Kv
D7 IN4005
R7 220
R3 1.2K
D6 IN4005
C4 240pF 1Kv
R8 18K
IC1 MC1466L
R9 8.66K 1%M.F.
D3 IN4005
D4 IN4005
C6 0.1
C3 0.01
R13 100 2W
D9 IN4738
D5 IN4005
R12 470K 2W
C7 20
475v
TP3
D8 IN5359A
TP4
R10 332K 1%M.F.
R11 147K 1%M.F.
AC LINE
26v
D2 KBF06
R2 1K 2W
C2 50 50v
PART OF T1
N.C.
N.C.
COMMON CATHODE H.V.
R7A 330K 2W
R7B 330K 2W
R8 47K 2W
D4 IN5369A
D3 IN5369A
D2 IN5232
C2 0.1
D5 IN916
C1 0.01
R2 3.9K
C4 2.0 100v
R5 200K 1% M.F. 3/4 W
C5 0.1uF 100V
C6 0.1uF 100V
D6 IN5374B
D7
Q1 MJ413
R6 200K 2W
G1 ADJ.
R4 150K 1% M.F. 3/4W
R9 270K 2W
R11 39K 2W
NOTE (1) G1 SET
-460v
TP2
NOTE (2) 20v 1.0v
TO BWO G1
TO METER CIRCUIT
* R13 27K
Q3 2N2405
TP1
Q2 2N3439
R3 2.7K
Q4 2N2405
R12 2.7K
R16 5.6K
R14 18K
R15 18K
C3 0.01
C5 0.01
R10 5.6K
IC1 H11A520
A11 G1C MODULATOR
P1101
R1 220
D1 IN5232A
J1012-5
J1007-9
AM MOD.
NOTE (1) WITH RESPECT TO CATHODE H.V.
NOTE (2) WITH RESPECT TO -G1 (475v).
* FACTORY SELECT.
ALL CAPACITANCES IN MICROFARADS, ALL RESISTANCES 1/2W,5%, UNLESS OTHERWISE NOTED.
MICRO-NOW INSTRUMENT
SCALE —
DATE 4-21-86
DR G.R.C. CKD
AP VD
REVISIONS
BY
DATE
TITLE MODEL 705C GRID 1 POWER SUPPLY AND MODULATOR
NO FIG. 7.11
BRUNING 40-105



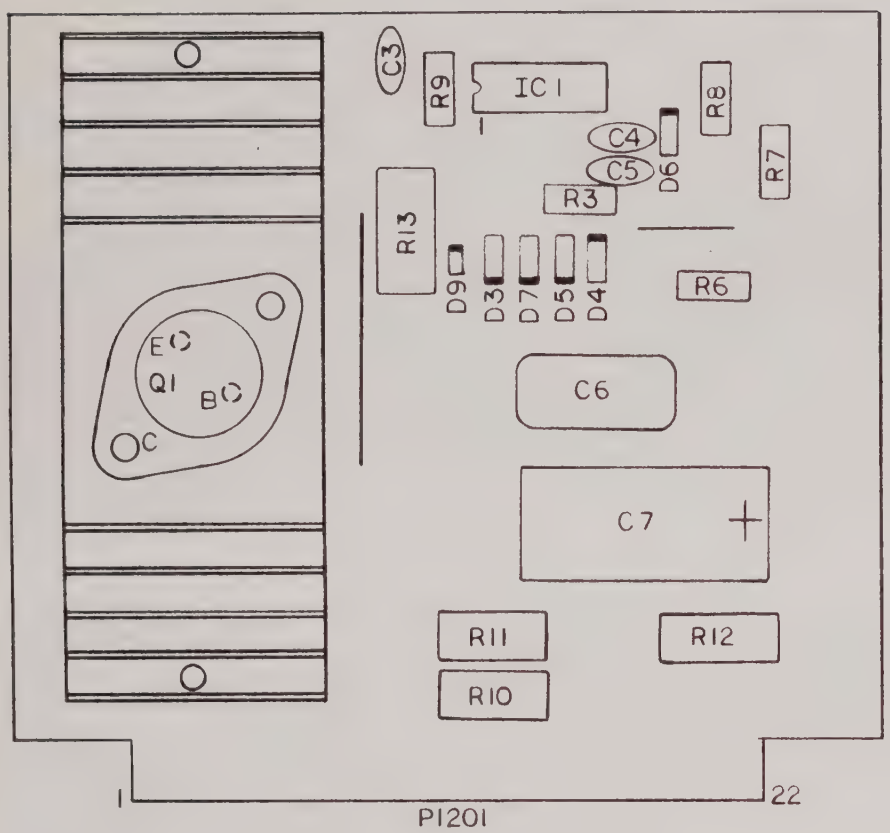
MICRO—NOW INSTRUMENT

SCALE FULL	REVISIONS	BY	DATE
DATE 4/12/86			
DR'N. MRA CKD.			
AP'VD			

TITLE
MODEL 705C EGI MODULATOR BOARD PARTS LAYOUT (A11)

NO.
FIG. 7.11A

BRUNING 40-105



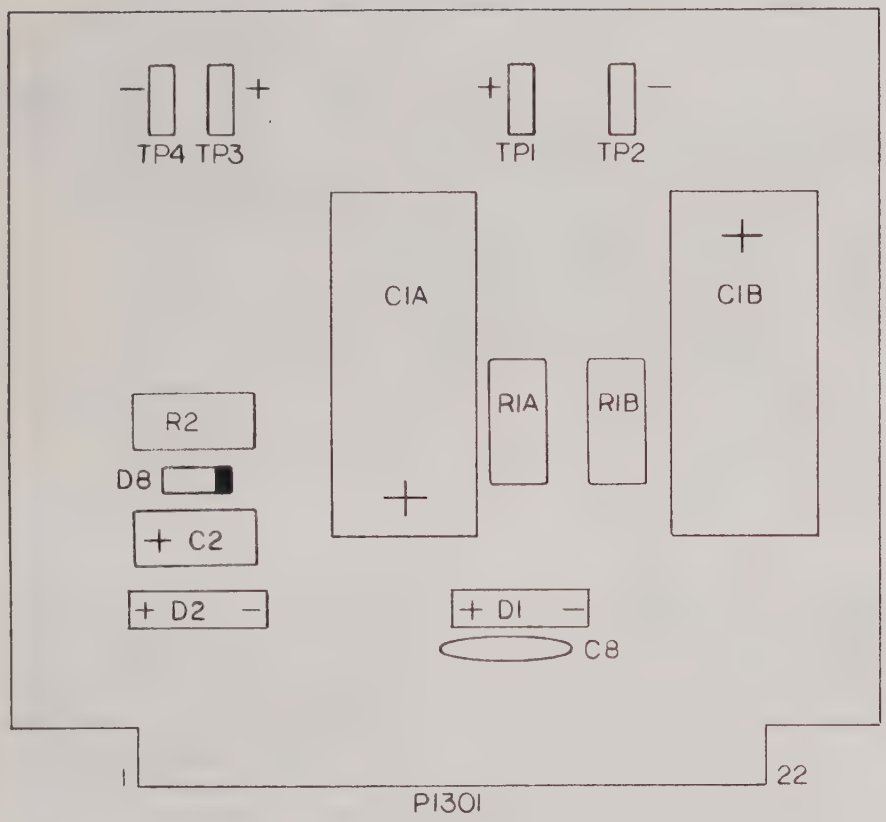
MICRO–NOW INSTRUMENT

SCALE N/A	REVISIONS REVISE TO 'C' ECN 705200	BY MRA	DATE 12/1/85
DATE 10-25-82			
DR'N MRA CKD			
AP'VD			

TITLE: MODEL 705C EGI REGULATOR BOARD PARTS LAYOUT (A12)

NO. FIG. 7.12

BRUNING 40-105



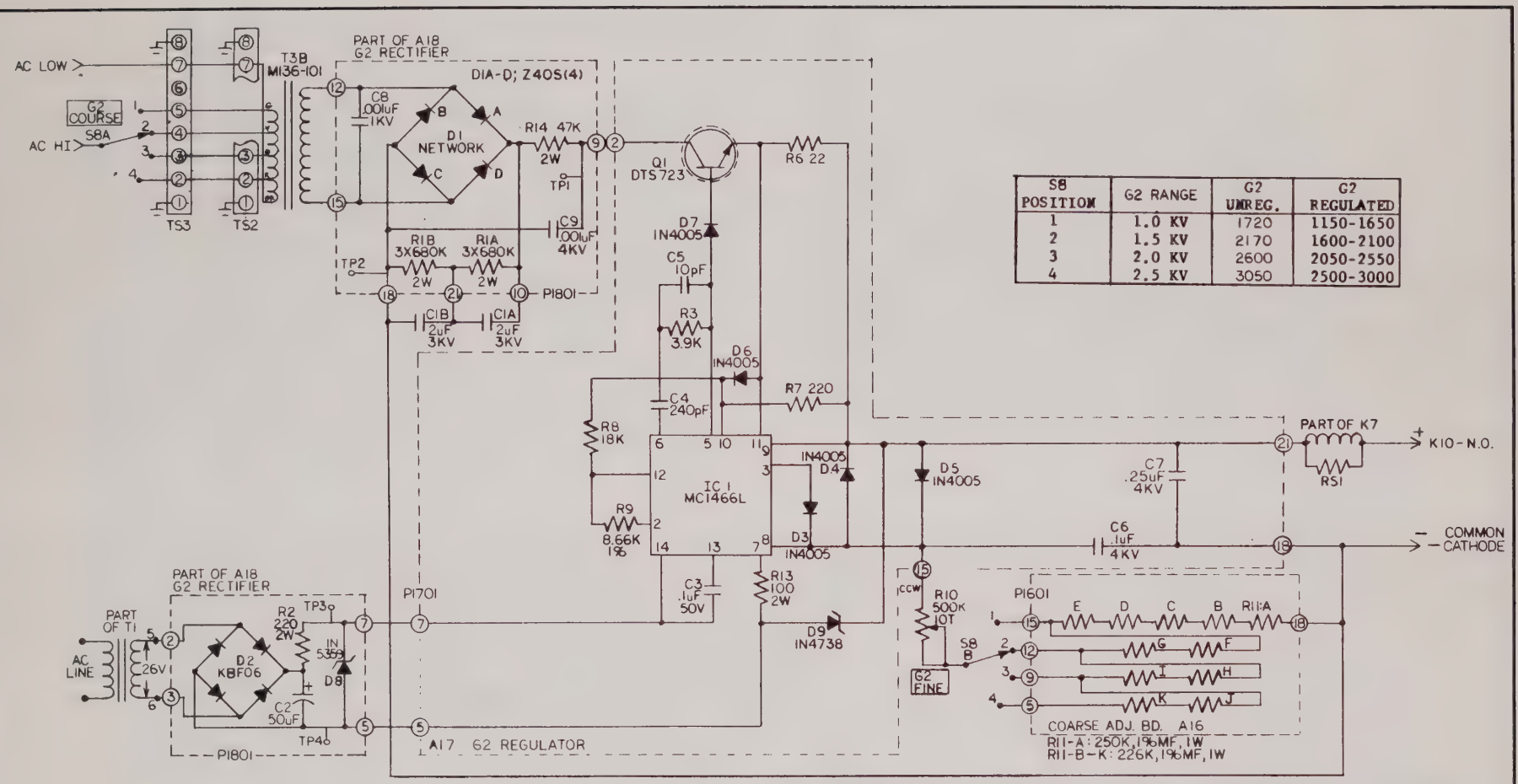
MICRO—NOW INSTRUMENT

SCALE N/A	REVISIONS	BY	DATE
DATE 12.12.85			
DR'N R.RA CK'D			
AP'VD			

TITLE
MODEL 705C GI RECTIFIER BOARD PARTS LAYOUT (A13)

NO.
FIG. 7.13

BRUNING 40-105



S8 POSITION	G2 RANGE	G2 UNREG.	G2 REGULATED
1	1.0 KV	1720	1150-1650
2	1.5 KV	2170	1600-2100
3	2.0 KV	2600	2050-2550
4	2.5 KV	3050	2500-3000

REVISIONS
ECN 705143 MRA 11/29/84
REVISE TO "C" MRA 12/13/85

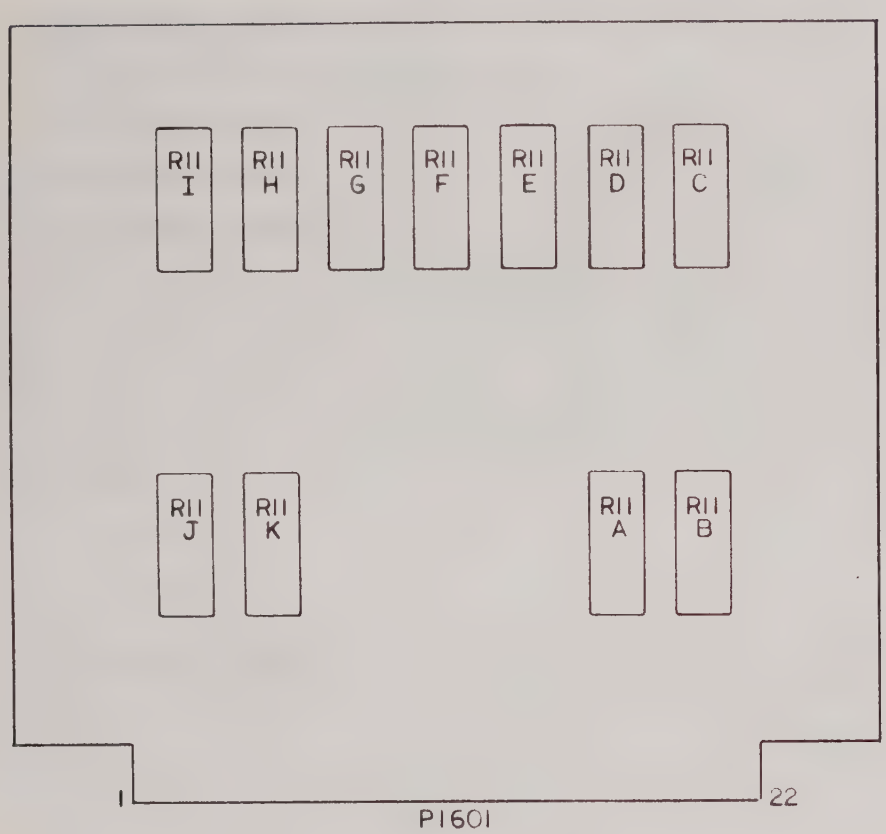
MICRO-NOW INSTRUMENT

SCALE N/A	REVISIONS NEW T3 AND CHANGED R11's AND OUTPUT	MRA	DATE 11/23/82
DATE 10/10/82	ADDED C8	MRA	12/2/82
DR'N MRA CHD. BSM	CHANGED R9 (A17)	MRA	2/16/83
AP'VD MRA	R3 CHANGED TO 3.9K/C8 ELIM ECN705118	MRA	4/4/83

TITLE MODEL 705C GRID 2 POWER SUPPLY

NO. FIG. 7.14

BRUNING 40-105



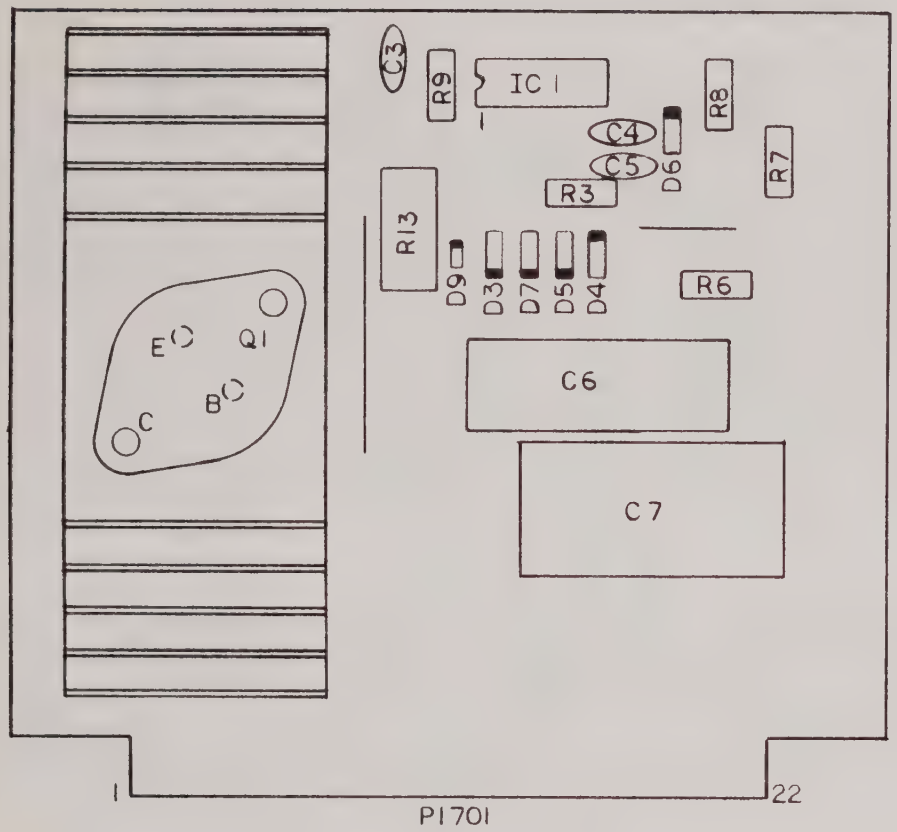
MICRO—NOW INSTRUMENT

SCALE N/A	REVISION A REVISIONS	BY	DATE
DATE 12-3-82	REVISE TO "C"	MA	12/13/85
DR'N MRA CKD			
AP'VD			

TITLE MODEL 705C EG2 COARSE ADJUST PARTS LAYOUT (A16)

NO. FIG. 7.15

BRUNING 40-105



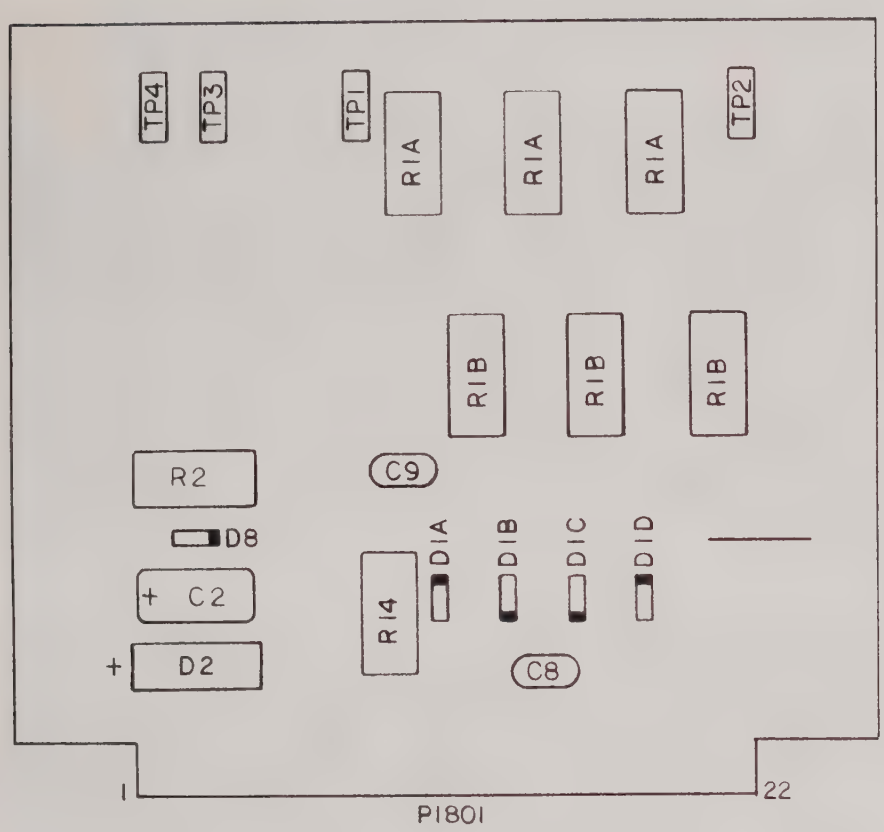
MICRO–NOW INSTRUMENT

SCALE N/A	REVISIONS C8 NOTE ADDED ECN 705118	BY MRA	DATE 4/4/83
DATE 10 25-82	REVISED TO "C" ECN 705200	MRA	4/14/86
DR'N MRA CKD			
AP'VD			

TITLE: MODEL 705C EG2 REGULATOR BOARD PARTS LAYOUT (A17)

NO: FIG. 7.16

BRUNING 40-105



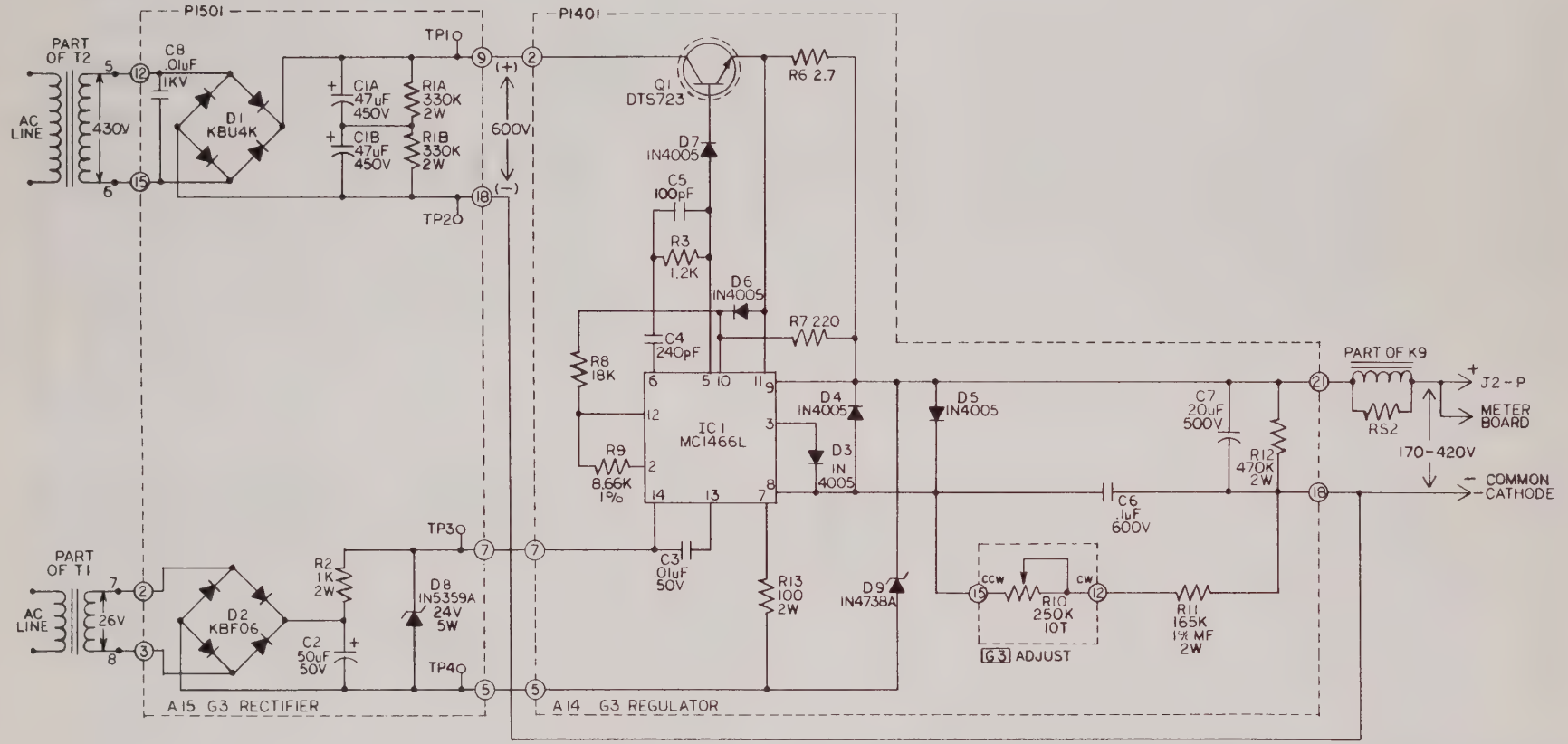
MICRO—NOW INSTRUMENT

SCALE N/A	REVISIONS: REVISED TO "C"	BY MRA	DATE 12/13/85
DATE 10-25-82			
DR N MRA CKD			
AP VD			

TITLE: MODEL 705C EG2 RECTIFIER BOARD PARTS LAYOUT (A18)

NO: FIG. 7.17

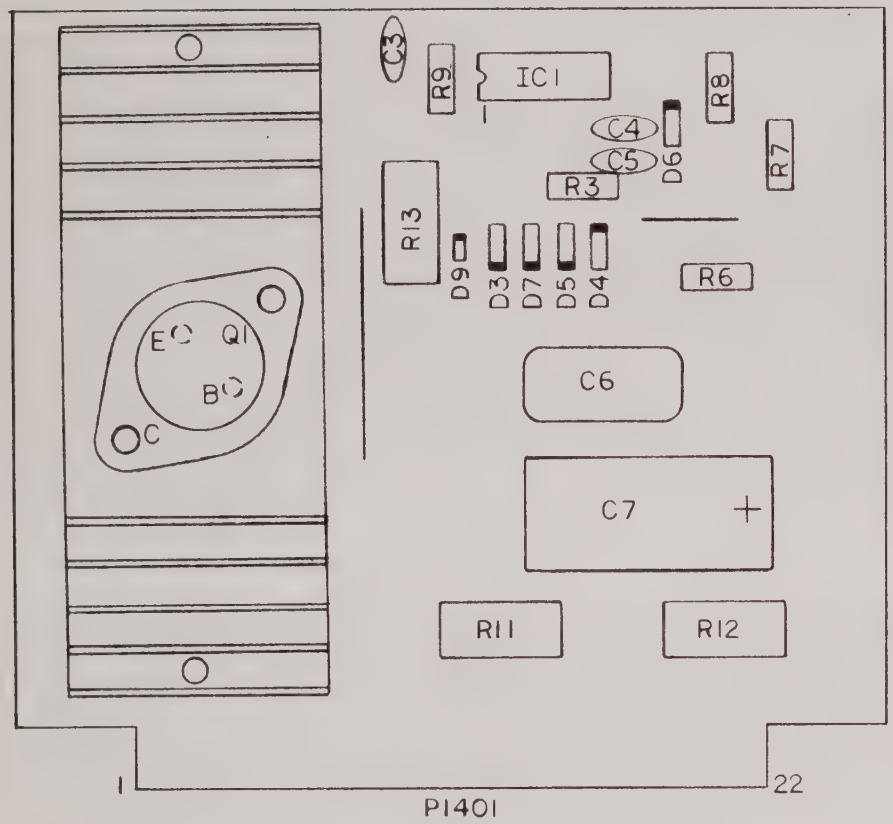
BRUNING 40-105



MICRO-NOW INSTRUMENT

SCALE NONE	REVISIONS REVISE TO "C" ECN 705200	BY MRA	DATE 4/11/86
DATE 10/13/82			
DR'N MRA CHK'D BSM			
APVD WW			
TITLE MODEL 705C GRID 3 POWER SUPPLY		NO FIG. 7.19	

BRUNING 40-105



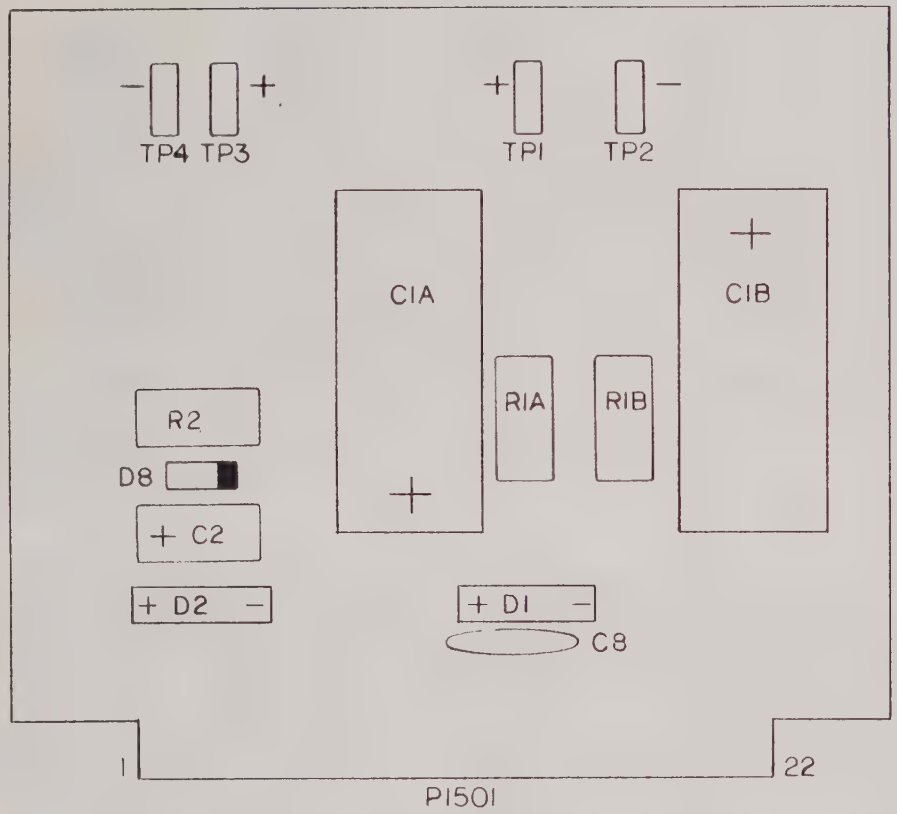
MICRO–NOW INSTRUMENT

SCALE N/A	REVISED TO "C" REVISIONS ECN 705200	BY MRA	DATE 12/13/85
DATE 10-25-82			
DR'N MRA CKD			
AP'VD			

TITLE
MODEL 705C EG3 REGULATOR BOARD PARTS LAYOUT (A14)

NO
FIG. 7.20

BRUNING 40-105



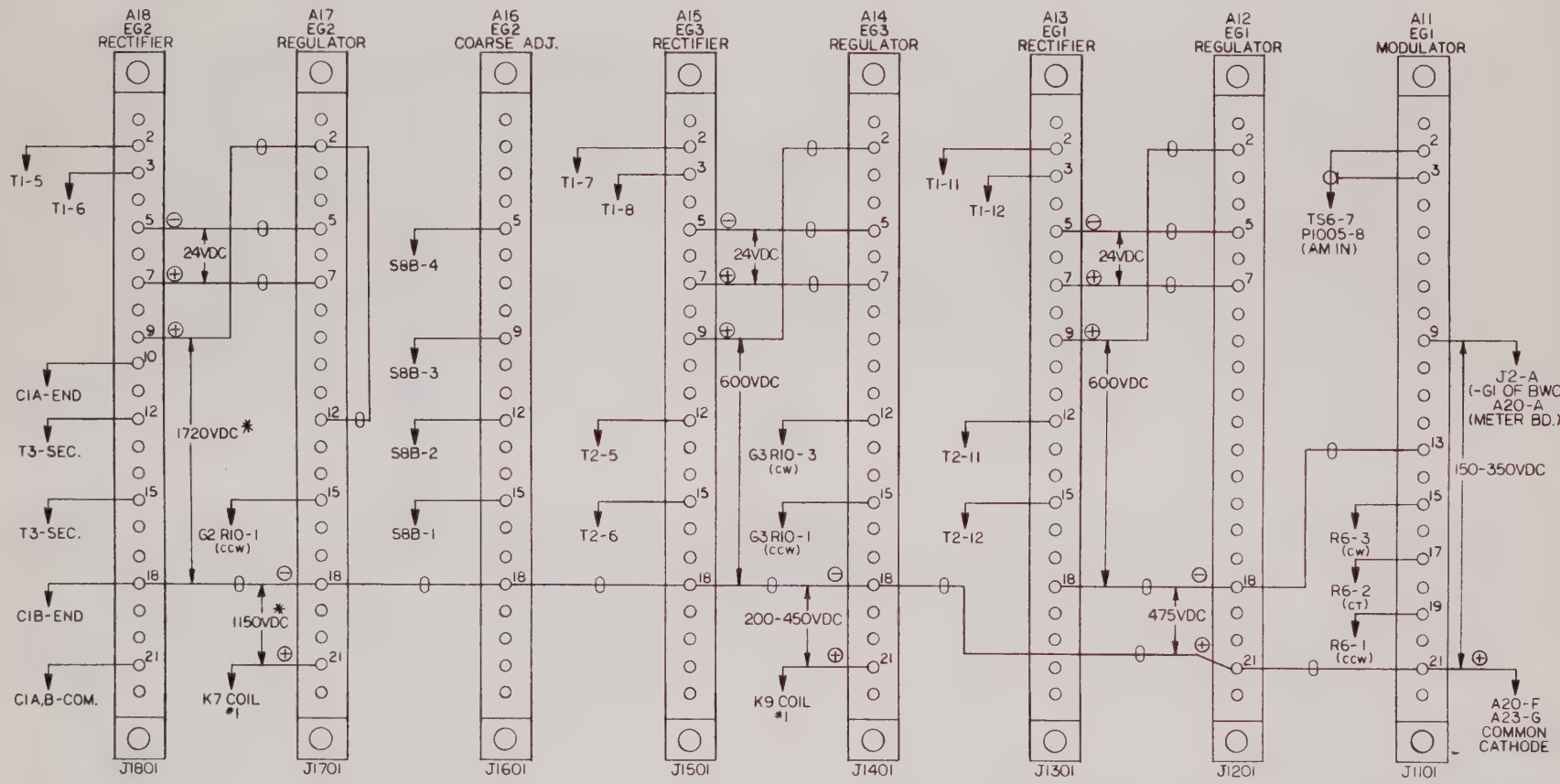
MICRO–NOW INSTRUMENT

SCALE N/A	REVISIONS	BY	DATE
DATE 12-12-85			
DR'N MRA CK'D			
AP'VD.			

TITLE
MODEL 705C G3 RECTIFIER BOARD PARTS LAYOUT (A15)

NO.
FIG. 7.21

BRUNING 40-105



*G2 COARSE SET AT 1KV POSITION; G2 FINE SET AT MINIMUM

VIEW FROM BOTTOM OF CARD GUIDE

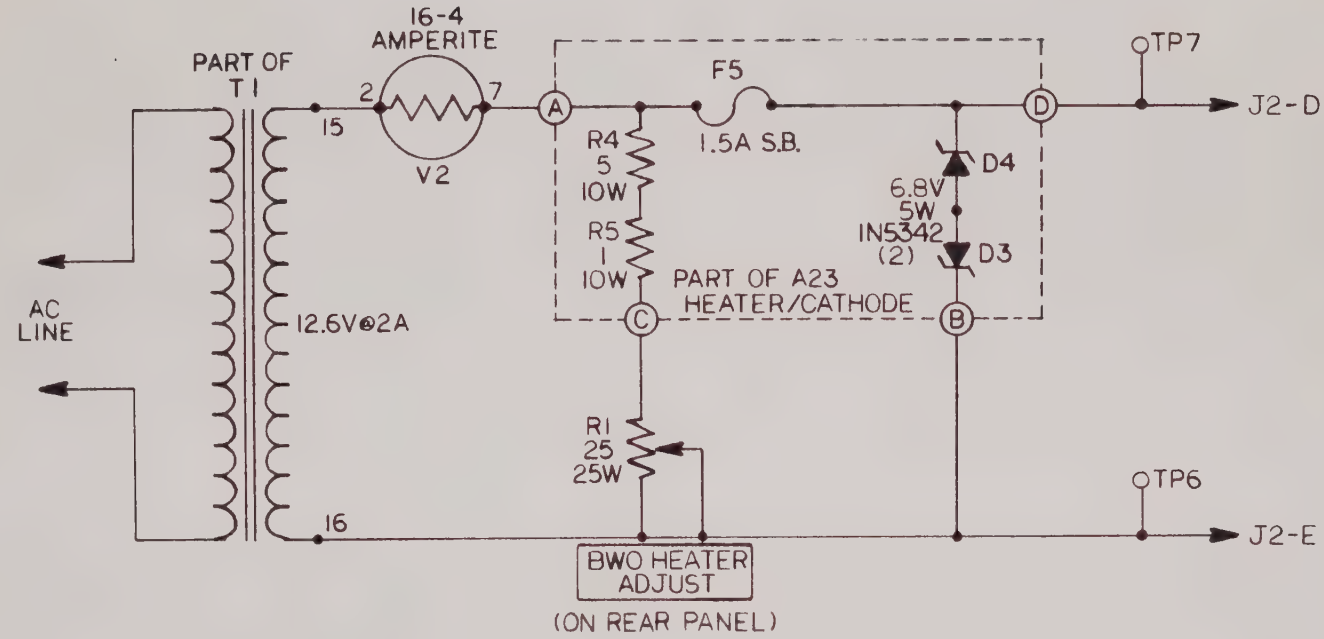
MICRO—NOW INSTRUMENT

SCALE NONE	REVISIONS: ADDED A17 BUS 2-12 FOR C8	BY MRA	DATE 12-6
DATE 12-2-82	REVISE TO "C" ECN 705200	MRA	4/1/83
DR'N MRA CK'D BBM			
APVD			

TITLE: MODEL 705C CARD GUIDE ASSEMBLY FOR A11-A18

NO: FIG. 7.22

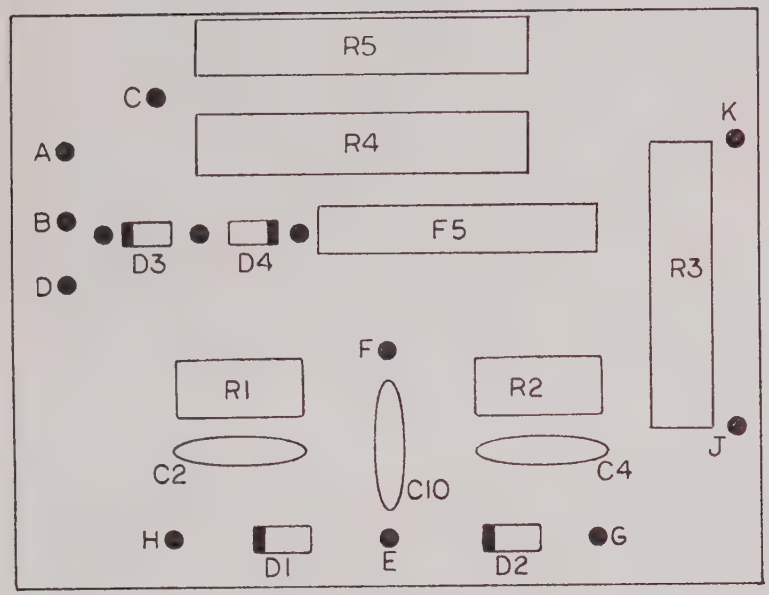
BRUNING 40-105



MICRO—NOW INSTRUMENT

SCALE N/A	REVISIONS CHANGE Z1,Z2 ADD R5 ECN 705122	BY MRH	DATE 6/20/83
DATE 12/6/82	REVISED TO "C" ECN 705200	MRA	12/13/85
DR'N MRH CKD			
APP'VD WRW			
TITLE MODEL 705C HEATER SUPPLY		NO FIG. 7.23	

BRUNING 40-105



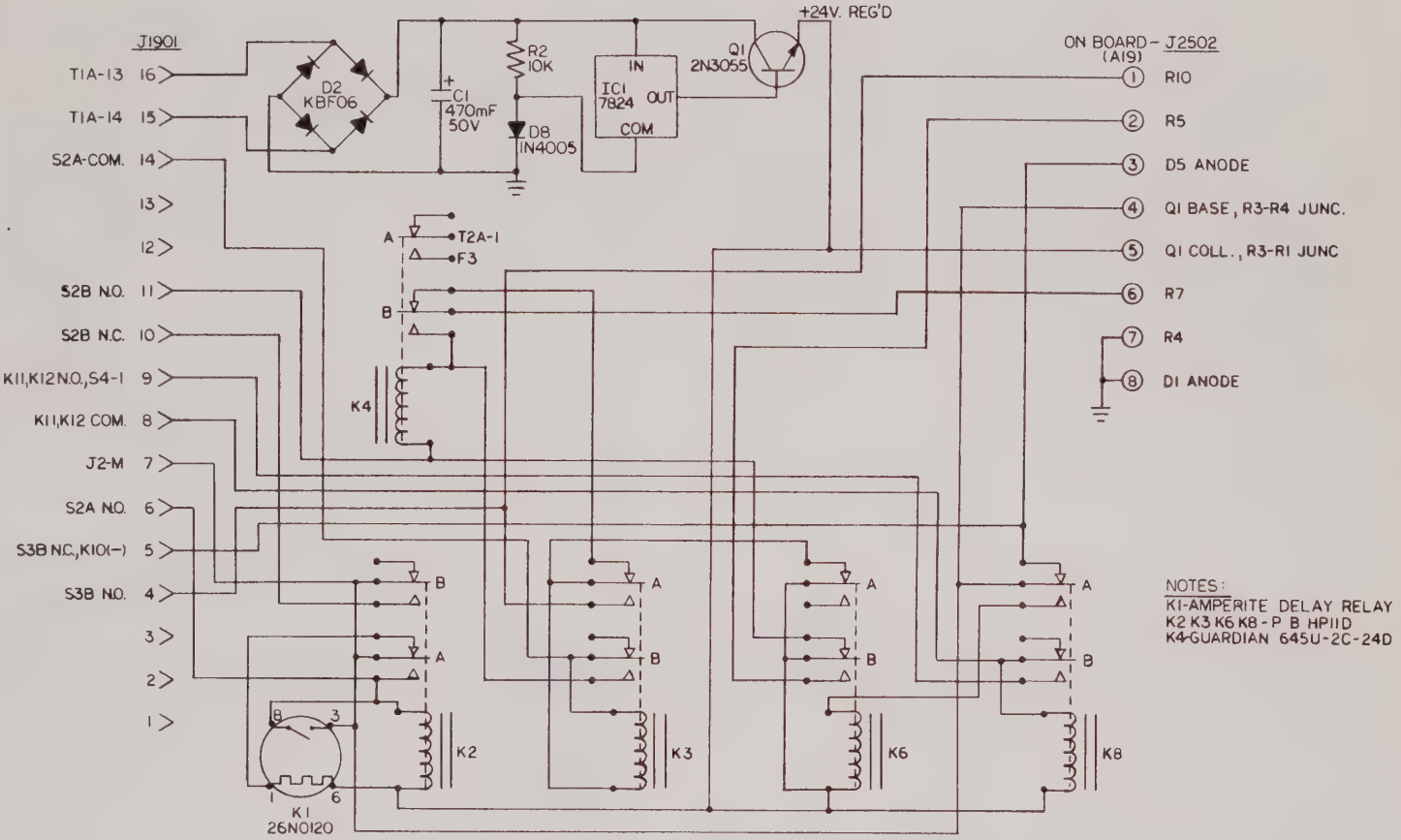
MICRO—NOW INSTRUMENT

SCALE N/A	REVISIONS REVERSE R3-J+K	BY MRA	DATE 9/8/86
DATE 12/13/85			
DR'N. MRA CKD			
AP'VD			

TITLE
MODEL 705C CATHODE-HEATER BOARD PARTS LAYOUT (A23)

NO.
FIG. 7.23A

BRUNING 40-105



NOTES:
K1-AMPERITE DELAY RELAY
K2 K3 K6 K8 - P B HP11D
K4-GUARDIAN 645U-2C-24D

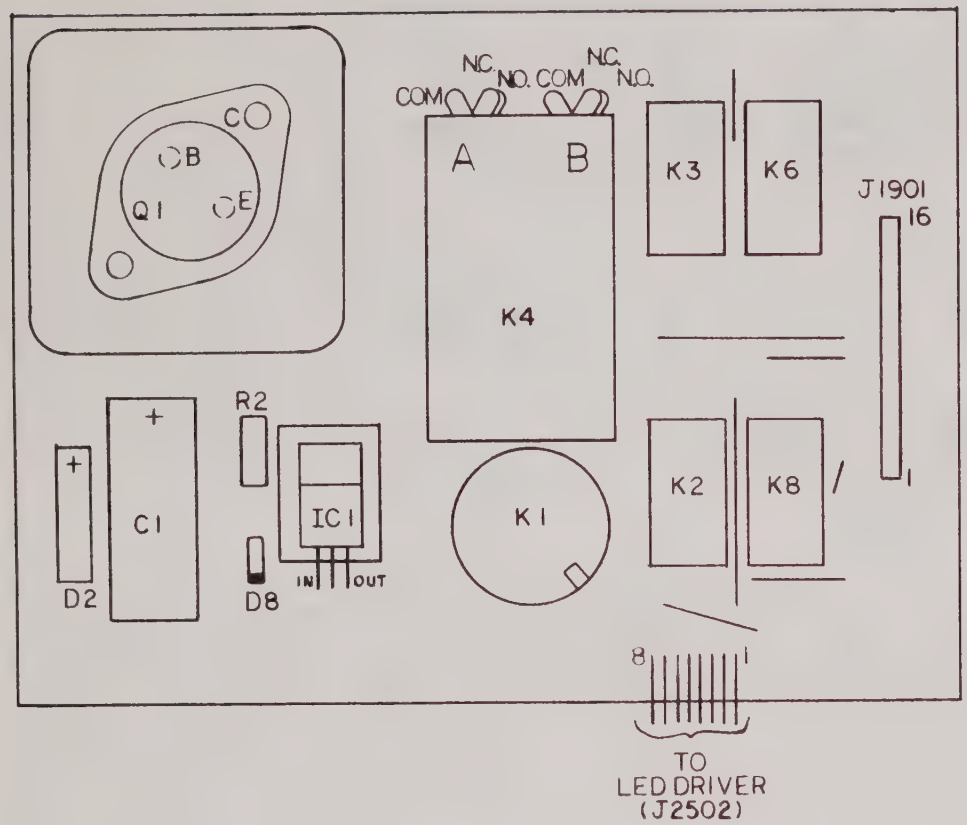
MICRO—NOW INSTRUMENT

SCALE N/A	REVISED TO "C" REVISIONS ECN 705200	MM	DATE 12/31/85
DATE 12/16/82			
DR'N MKM CHK'D BBM			
APVD WCW			

TITLE MODEL 705C RELAY MOD. BOARD SCHEMATIC (A19)

NO FIG. 7.24

BRUNING 40-105



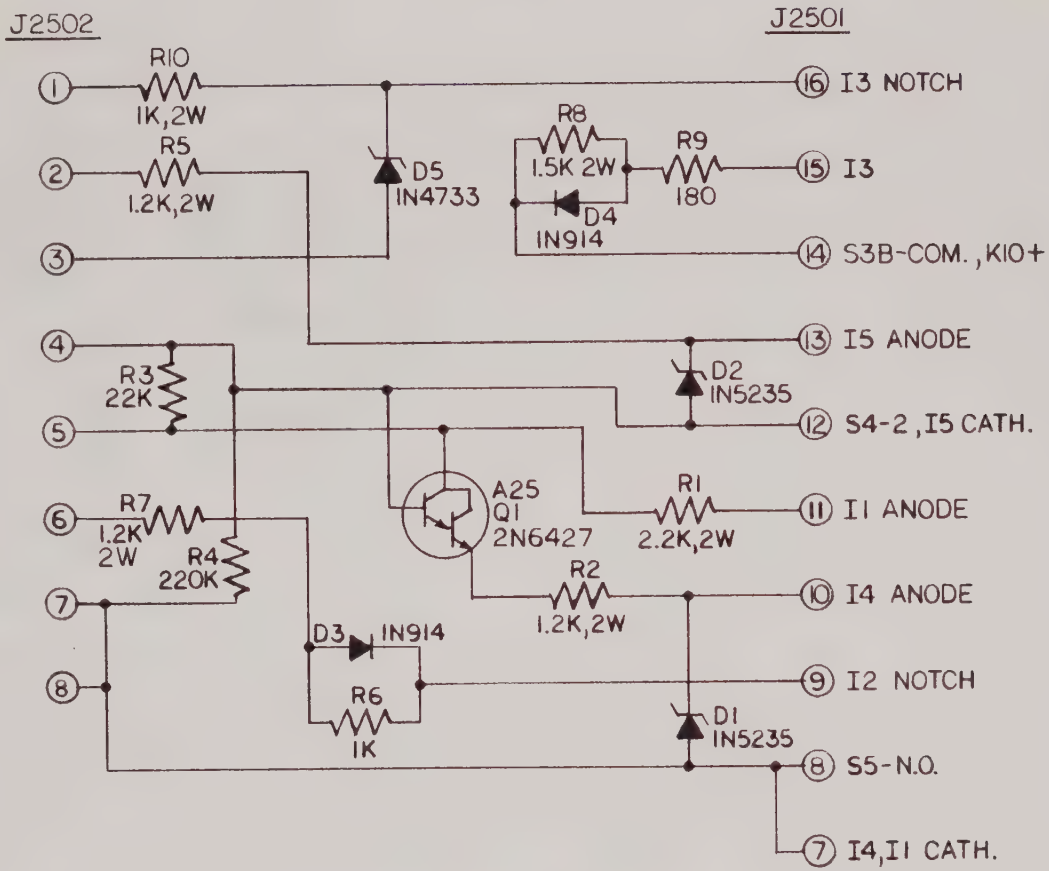
MICRO—NOW INSTRUMENT

SCALE N/A	REVISIONS REVISED TO "C" ECN 705200	BY MRA	DATE 12/13/85
DATE 10-26-82			
DR'N MRA / CKD			
AP'VD			

TITLE
MODEL 705C RELAY MODULE BOARD PARTS LAYOUT (A19)

NO
FIG. 7.24A

BRUNING 40-105



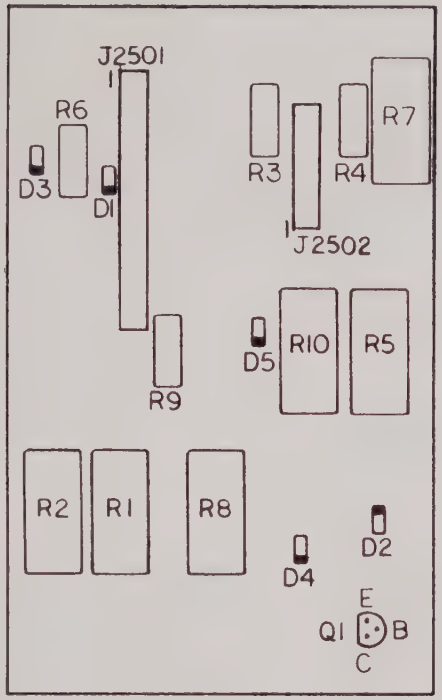
MICRO-NOW INSTRUMENT

SCALE N/A	REVISIONS REVISED TO "C" FLN 705-200	BY MRM	DATE 12/13/85
DATE 12/15/82			
DR'N MRM CKD			
AP'VD WRO			

TITLE MODEL 705C LED DRIVER BOARD SCHEMATIC (A25)

NO. FIG. 7.25

BRUNING 40-105



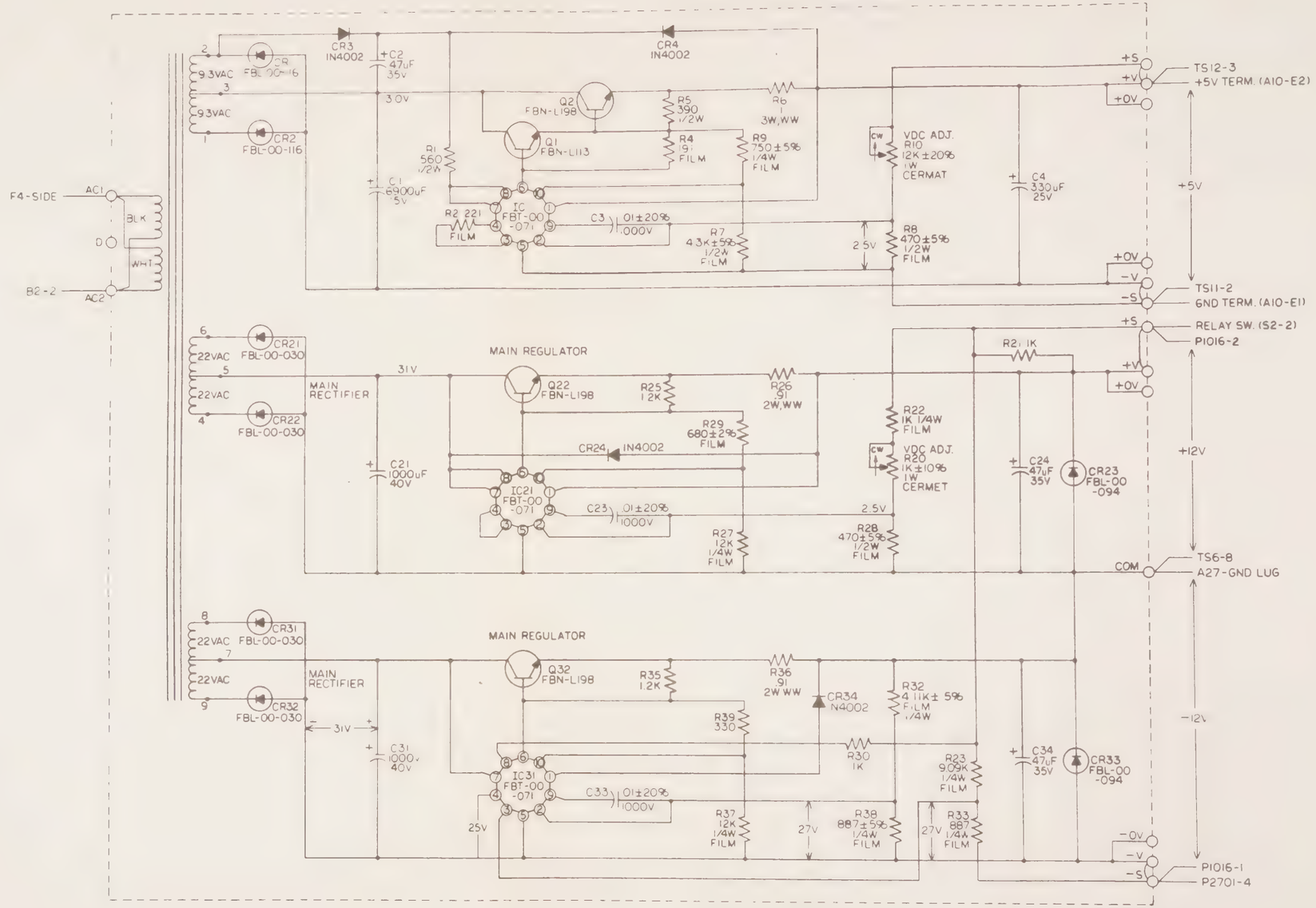
MICRO—NOW INSTRUMENT

SCALE N/A	REVISIONS REVISED TO "C" ECN 705-200	BY MRA	DATE 12/13/85
DATE 10-26-82			
DR'N MRA CKD			
AP'VD			

TITLE
MODEL 705C LED DRIVER BOARD PARTS LAYOUT (A25)

NO
FIG. 7.25A

BRUNING 40-105

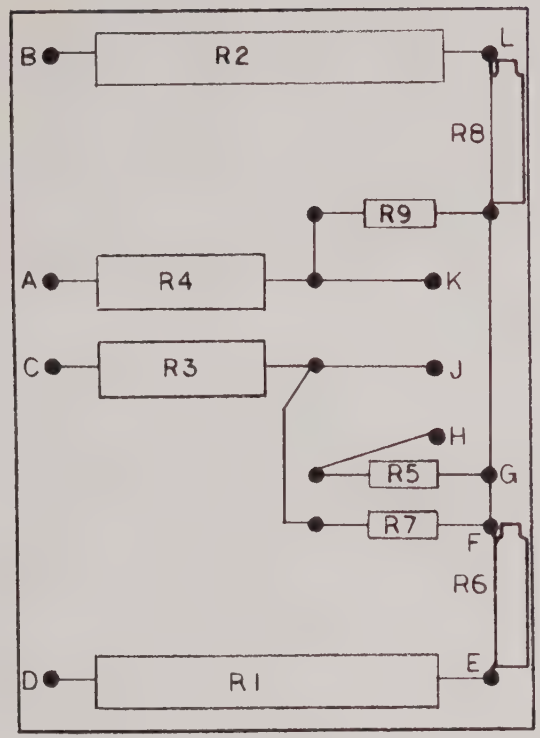


MICRO-NOW INSTRUMENT

SCALE N/A	REVISIONS	BY	DATE
DATE 4/21/86			
DR'N NKA / CKD			
AP'V'D			

TITLE: MODEL 705C LAMBDA POWER SUPPLY-LOT-X-5152-A (PS1)

NO: FIG. 7.27



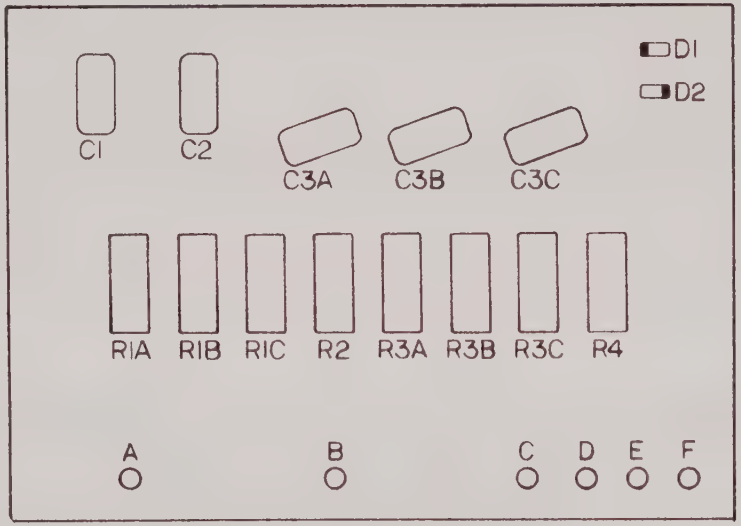
MICRO—NOW INSTRUMENT

SCALE NONE	REVISIONS ECN 705136 S/N 2570 AND UP	BY M	DATE 6/6
DATE 6/6/84	REVISED TO "C" ECN 705200	MPA	12/13/85
DR'N. BWS / CKD			
AP'VD			

TITLE MODEL 705C METER BD. PARTS LAYOUT (A20)

NO. FIG. 7.28

BRUNING 40-105



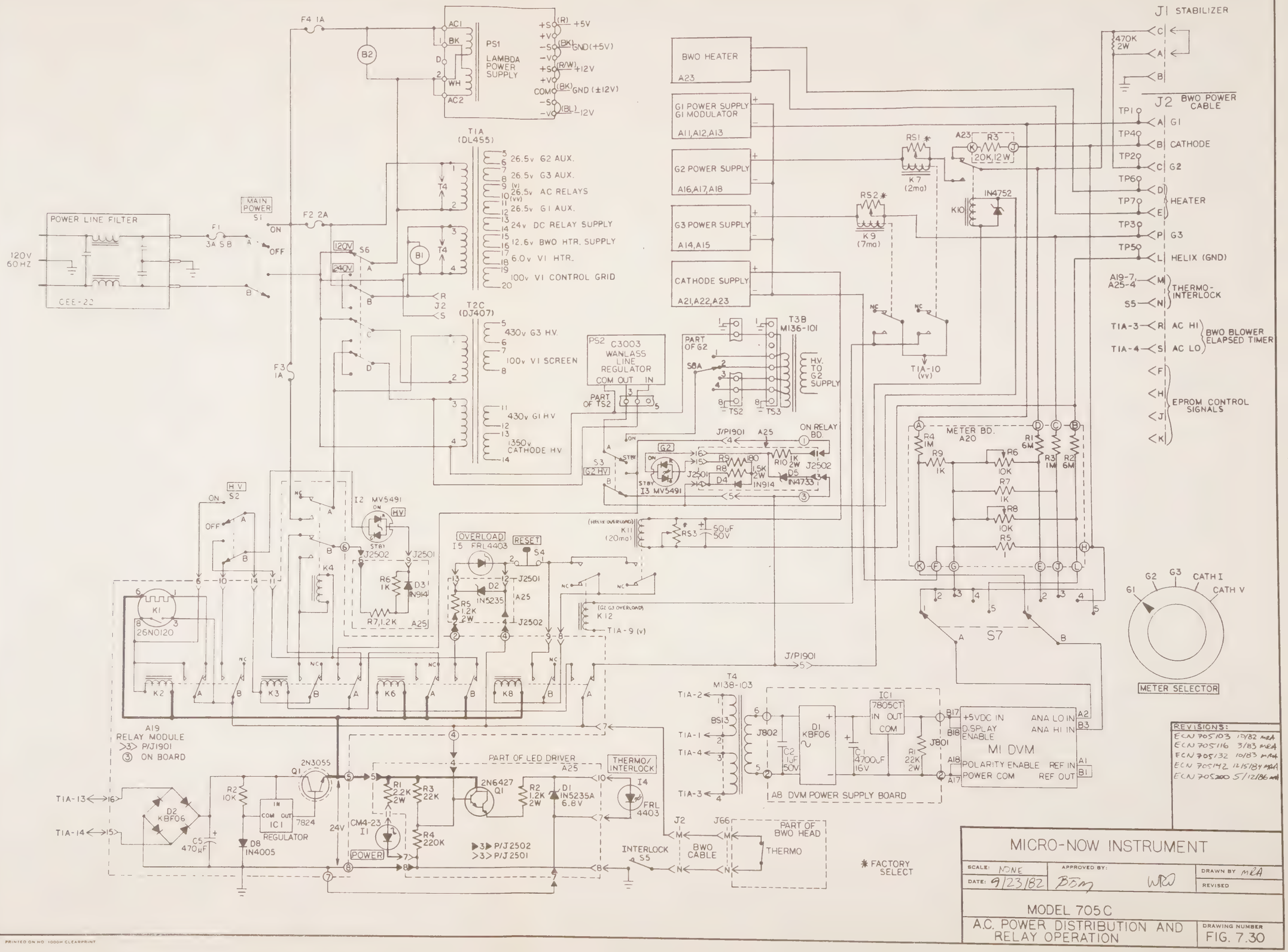
MICRO-NOW INSTRUMENT

SCALE FULL	REVISIONS	BY	DATE
DATE 4/14/86			
DR'N MRA CKD			
AP'VD			

TITLE MODEL 705C FEEDBACK BOARD PARTS LAYOUT (A21)

NO. FIG. 7.29

BRUNING 40-105



REVISIONS:
ECN 705103 12/82 MRA
ECN 705116 3/83 MRA
ECN 705132 10/83 MRA
ECN 705142 12/15/84 MRA
ECN 705200 5/12/86 MRA

MICRO-NOW INSTRUMENT

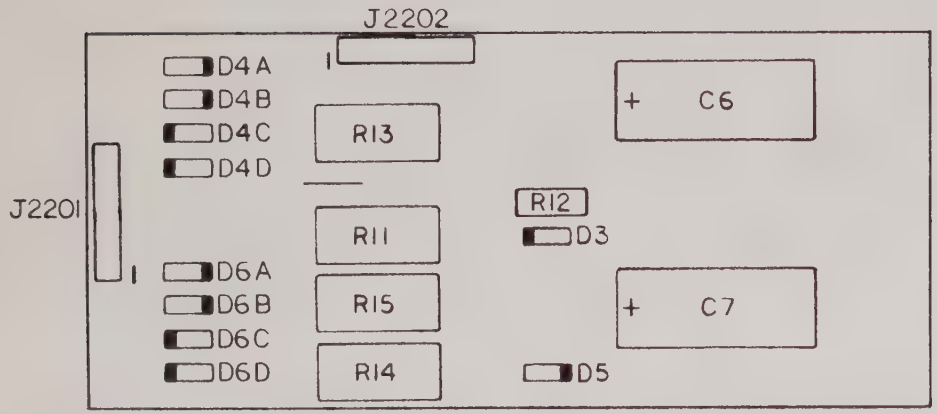
SCALE: NONE	APPROVED BY: BDM WRW	DRAWN BY MRA
DATE: 9/23/82		REVISED

MODEL 705C

A.C. POWER DISTRIBUTION AND RELAY OPERATION

DRAWING NUMBER FIG. 7.30

18324 PRINTED ON NO 1000H CLEARPRINT



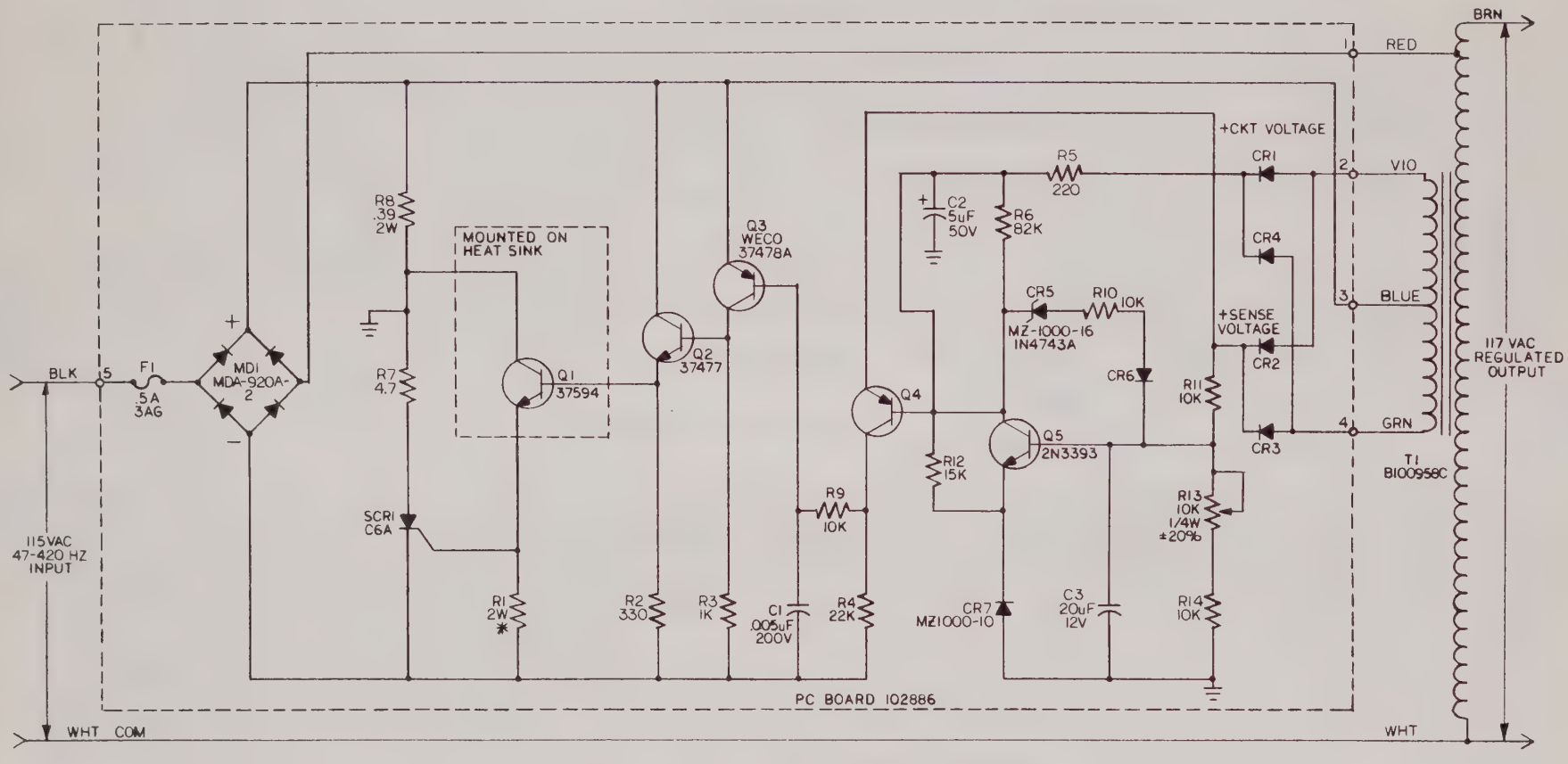
MICRO—NOW INSTRUMENT

SCALE N/A	REVISIONS REVISED TO "C" ECN 705200	BY MRA	DATE 12/13/85
DATE 10-26-82			
DR'N MRA CKD			
AP VD			

TITLE: MODEL 705C PASS TUBE GRID SUPPLY PARTS LAYOUT (A22)

NO: FIG. 7.31

BRUNING 40-105



NOTES: UNLESS OTHERWISE SPECIFIED
1. RESISTORS ARE 1/2W AND 10%
   VALUES ARE IN OHMS
2. DIODES ARE TYPE IN485A
* FACTORY SELECT

MICRO—NOW INSTRUMENT

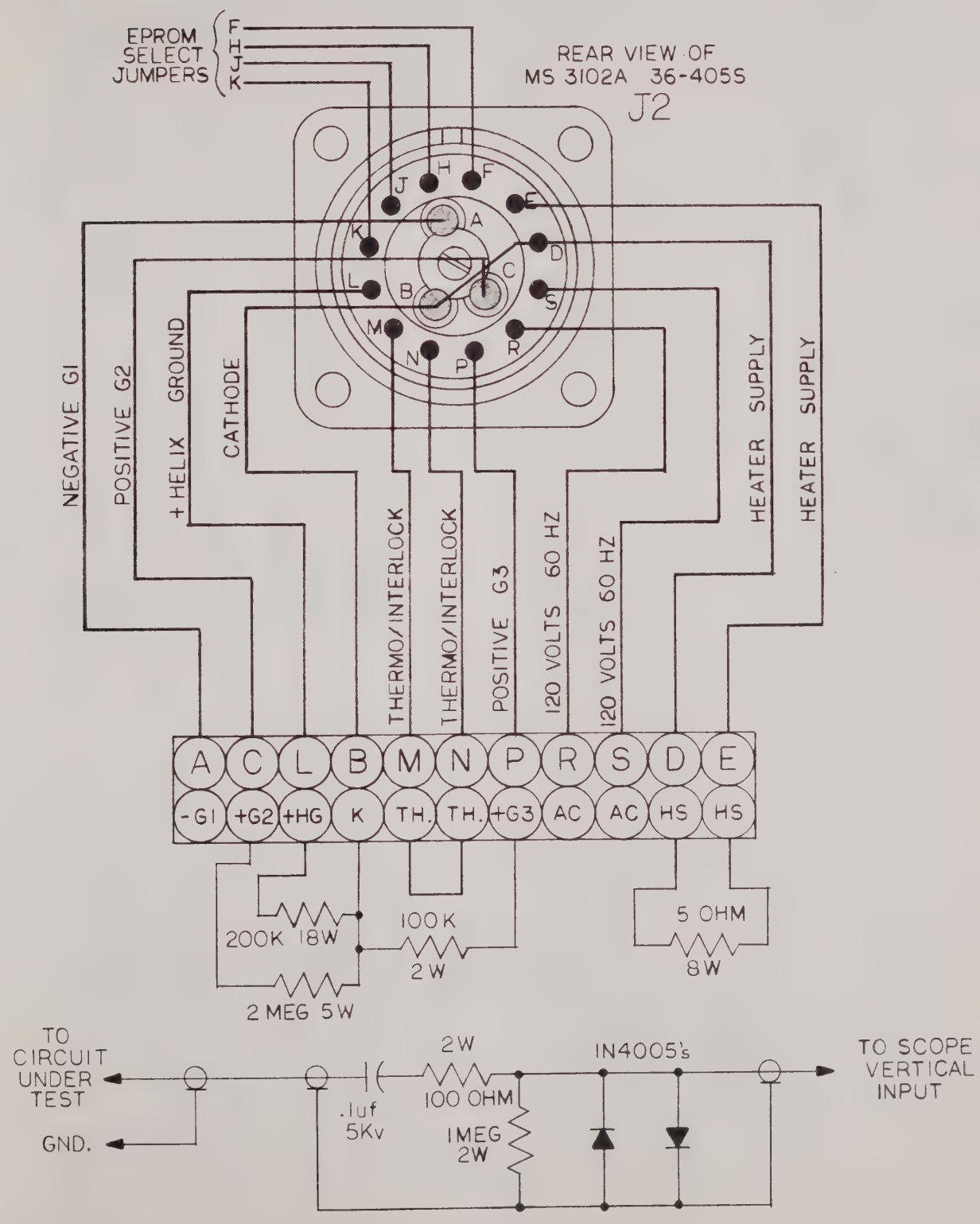
SCALE NONE	REVISIONS: REVISE TO "C" ECN 705200	BY MRA	DATE 9/11/86
DATE 1/18/83			
DR'N MRA CK'D			
AP VD			

TITLE: MODEL 705C WANLASS C3003 POWER SUPPLY (PS 2)

NO: FIG. 7.32

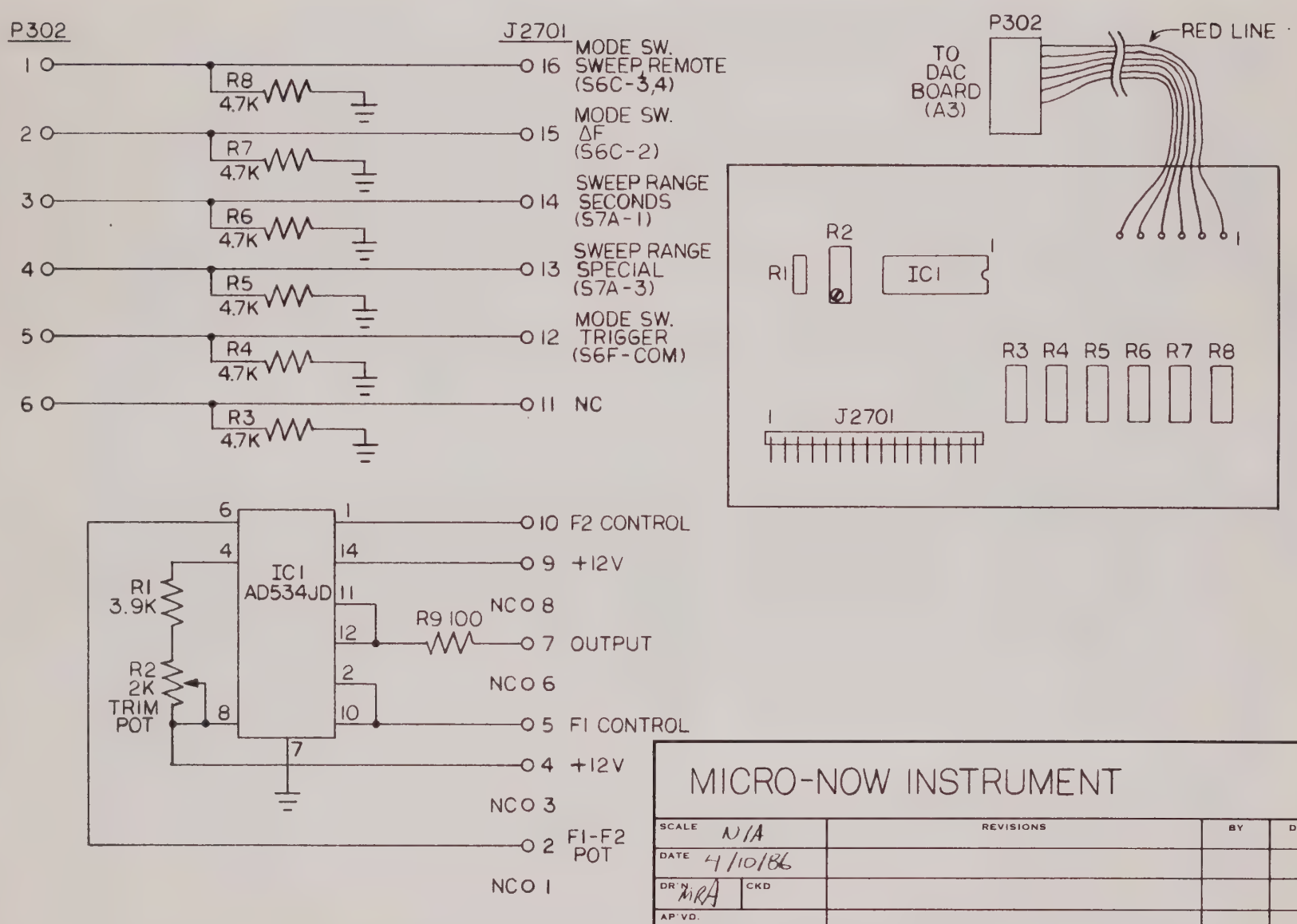
BRUNING 40-105

705C
BWO DUMMY LOAD CONNECTIONS



RIPPLE TESTER

FIG. 7.33



MICRO-NOW INSTRUMENT

SCALE N/A	REVISIONS	BY	DATE
DATE 4/10/86			
DR'N MRA CKD			
AP'VD.			

TITLE: MODEL 705C MANUAL F1-F2 BOARD (A27)

NO. FIG. 7.34

BRUNING 40-105

SECTION 8 PARTS LISTS

LIST OF ASSEMBLIES

UNIT DESIGNATION	DESCRIPTION	FIGURE NO.
A1	Computer Board	7.1
A2	Display Buffer Board	7.2
A3	Digital to Analog Converter	7.3
A4	Analog Processor Board	7.4
A5	Auxiliary Board	7.5
A6	GPIB (IEEE 488) Board	7.6
A7	EPROM Select Board	7.7
A8	DVM Power Supply Board	7.8
A9	Display Panel	7.2
A10	Mother Board	7.10
A11	G1 Modulator Board	7.11
A12	G1 Regulator Board	7.11
A13	G1 Rectifier Board	7.11
A14	G3 Regulator Board	7.19
A15	G3 Rectifier Board	7.19
A16	G2 Coarse Adjust Board	7.14
A17	G2 Regulator Board	7.14
A18	G2 Rectifier Board	7.14
A19	Relay Module	7.24
A20	Meter Board	7.28
A21	Cathode Supply Feedback Board	7.29
A22	Pass Tube Grid Supply Board	7.31
A23	Heater/Cathode Supply Board	7.23
A24	Manual EPROM Board	7.7
A25	LED Driver Board	7.25
A26	Overload Relay Assembly	7.26
A27	DVM Power Supply Board	7.34
	Main Mounting Plate	
	Rear Panel	
	Front Panel	
	Center Divider Panel	
	Right Side Panel	

A1 MICROCOMPUTER BOARD 705C01

CKT. REF.	MNI PART#	DESCRIPTION AND MANUFACTURER			
Integrated Circuits					
IC1, 7	030018	SN74LS244			
IC2, 3	030015	SN74LS37			
IC4, 5	030017	SN74LS242			
IC6	034001	MC68A00P			
IC8, 9	033001	HN462732G			
IC10, 11	033003	MK4801A-90			
IC13	034002	MC6875L			
IC14	030016	SN74LS138			
Chokes					
L1	044005	6.8 uH			
Crystal					
X1	077003	6.000 MHz			
Resistors					
R1	010041	1 kohm	1/4W	5%	Carbon Comp.
R2, R4	010048	3.3 kohm	1/4W	5%	Carbon Comp.
R3, R5	010055	10 kohm	1/4W	5%	Carbon Comp.
Capacitors					
C1	001010	100 pF	1000WV	Ceramic	
C2, 17, 18	009001	22 uF	16WV	Tantalum	
C3-16	009027	0.1 uF	50WV	Monolithic	

A2 DISPLAY BUFFER BOARD 705C02

Integrated Circuits				
IC1, 2	033004	ICM7218C1J1		
IC3	031002	MC68A21P		
IC4	030021	SN74LS240N		
IC5, 8	030016	SN74LS138N		
IC6	030020	SN74LS32N		
IC7	030019	SN74LS27N		
IC9	030022	SN74LS148N		
Chokes				
L1, L2	044009	1 mH		
Capacitors				
C1	002006	100 MFD	25WV	Electrolytic
C2-5	001025	0.1 uF	50WV	Ceramic
C6, 7	002019	4700 MFD	16WV	Electrolytic

A3 DIGITAL TO ANALOG CONVERTER BOARD 705C03

CKT. REF.	MNI PART#	DESCRIPTION AND MANUFACTURER			
Integrated Circuits					
IC1, 2	033002	MC14016BCP			
IC3	032029	TL082CP			
IC4, 12, 13	030004	SN7404N			
IC5	030011	AD7533LN			
IC6, 14	030008	SN7442N			
IC7, 8, 9	031002	MC68A21P			
IC10, 11	031003	N8T26AN			
IC15	030024	AD7541JN			
IC16	032021	MLM358P			
IC17	030007	SN7430N			
IC18	030003	SN7400N			
IC19	030035	SN7417N			
IC20	030012	AD582KD			
IC21, 22	030034	AD534JD			
IC23	032038	MC3403P			
IC24	033010	MC14053BCP			
Capacitors					
C1	002006	100 MFD	50WV	Electrolytic	
C2-7	001024	0.01 uF	50WV	Ceramic	
C8,10,12-16, 18,21,22,23	009027	0.1 uF	50WV	Monolithic	
C9	001004	22 pF	1000WV	Ceramic	
C11	001010	100 pF	1000WV	Ceramic	
C17	003011	0.01 uF	50WV	Polystyrene	
C19, 20	009007	1 uF	25WV	Tantalum	
Resistors					
R1	010055	10 kohm	1/4W	5%	Carbon Comp.
R2	016030	1 kohm	1/2W	10%	Trimmer
R3	016022	10 kohm	1/2W	10%	Trimmer
R4	016031	5 kohm	1/2W	10%	Trimmer
R5,6,7,10,11, 12,14,15	010050	4.7 kohm	1/4W	5%	Carbon Comp.
R8	011012	19.5 kohm	1/2W	1%	Carbon Film
R9, 13	011013	20 kohm	1/2W	1%	Carbon Film
R16	010041	1 kohm	1/4W	5%	Carbon Comp.
R17, 18	010047	3 kohm	1/4W	5%	Carbon Comp.
R19	016023	2 kohm	1/2W	10%	Trimmer
Diode					
D1	022003	1N914	100V	200 mA	
Chokes					
L1-4	044005	6.8 uH			

A4 ANALOG PROCESSOR BOARD 705C04

CKT. REF.	MNI PART#	DESCRIPTION AND MANUFACTURER		
Integrated Circuits				
IC1-4,7,10	032021	MLM358N	Linear	
IC5	030005	SN7414N	Schmidt Trigger	
IC6	030009	SN74LS28N		
IC8	032020	MC1536G		
IC9	030010	SN74LS629N	VCO	
IC12	030004	SN7404N	Hex Inv.	
Transistors				
Q1	028006	2N5416	PNP	
Diodes				
D1-4	024003	ECG109	Germanium	
D5-15	022005	1N459		
D16	023022	1N4761A	Zener	75V 1W
D17	023028	1N4733A	Zener	5.1V 1W
Chokes				
L1	044005	6.8 uH		
Capacitors				
C3	003012	0.22 uF	100WV	
C5	001025	0.1 uF	50WV	Ceramic
C6	001016	470 pF	50WV	Ceramic
C7	001002	10 pF	1000WV	Ceramic
C8, 11, 15	001024	0.01 uF	50WV	Ceramic
C9, 10	002006	100 MFD	25WV	Electrolytic
C12	002010	2.2 MFD	50WV	Electrolytic
C13		Factory Select (20 pF nominal)		
C14	002005	47 MFD	25WV	Electrolytic
C16	001010	100 pF	1000WV	Ceramic
C17	001035	0.0047 uF	50WV	Ceramic

A4 ANALOG PROCESSOR BOARD 705C04 (CON'T)

CKT. REF.	MNI PART#	DESCRIPTION AND MANUFACTURER			
Resistors					
R1-8,14,15	011010	10 kohm	1/2W	1%	Carbon Film
R9, 10	010046	2.7 kohm	1/4W	5%	Carbon Comp.
R16,45,54,55	010041	1 kohm	1/4W	5%	Carbon Comp.
R18	011001	80.6 ohm	1/2W	1%	Carbon Film
R19-25	011002	100 ohm	1/2W	1%	Carbon Film
R26	011003	121 ohm	1/2W	1%	Carbon Film
R27-35	011015	46.4 kohm	1/2W	1%	Carbon Film
R36		Factory Select (470 kohm nominal)			
R37		Factory Select (15 kohm nominal)			
R38	011005	750 ohm	1/2W	1%	Carbon Film
R39,44,53	011011	15 kohm	1/2W	1%	Carbon Film
R40	010070	150 kohm	1/4W	5%	Carbon Comp.
R41	010074	330 kohm	1/4W	5%	Carbon Comp.
R42,56	010050	4.7 kohm	1/4W	5%	Carbon Comp.
R43	010051	5.6 kohm	1/4W	5%	Carbon Comp.
R46	010068	100 kohm	1/4W	5%	Carbon Comp.
R47	010058	18 kohm	1/4W	5%	Carbon Comp.
R48	011014	26.7 kohm	1/2W	1%	Carbon Film
R50	016006	1 kohm	1/2W	20 Turn	Cermet 704102
R51, 52	016007	10 kohm	1/2W	20 Turn	Cermet 704103
R57	010007	3.3 ohm	1/4W	5%	Carbon Comp.
R58	010115	470 ohm	1/4W	5%	Carbon Comp.

A5 AUXILIARY BOARD 705C05

Integrated Circuits				
IC1	032029	TL082CP		
IC2	032007	LM741CN		
IC4	030004	SN7404N		
Transistors				
Q1		2N2916	Dual NPN	
Q2	028004	MPS3638A	PNP	
Q3	025001	2N706	NPN	
Q4, 5	028005	2N699	NPN	
Q6	025002	2N3866	NPN	
Capacitors				
C1, 2	001025	0.1 uF	50WV	Ceramic
C3	001023	0.05 uF	50WV	Ceramic
C9, 10	001035	0.005 uF	50WV	Ceramic
C11	001002	10 pF	1000WV	Ceramic
Chokes				
L1-4	044020	20 mH		
Diodes				
D1-5	022004	1N916		

A5 AUXILIARY BOARD (Continued)

CKT. REF.	MNI PART#	DESCRIPTION AND MANUFACTURER			
Relay					
K1	047004	RS5D	SPDT,12 V dc Potter & Brumfield		
Resistors					
R1,2,10,22, 26,52	010055	10 kohm	1/4W	5%	Carbon Comp.
R3,24	010045	2.2 kohm	1/4W	5%	Carbon Comp.
R4,5	016010	5 kohm	1/2W		Cermet Trim Pot
R6	010056	12 kohm	1/4W	5%	Carbon Comp.
R7,16	010052	6.8 kohm	1/4W	5%	Carbon Comp.
R8,36-38,56	010034	330 ohm	1/4W	5%	Carbon Comp.
R9,19,21	010041	1 kohm	1/4W	5%	Carbon Comp.
R11,12	010235	20 kohm	1/4W	5%	Carbon Comp.
R13,18	010233	1 Mohm	1/4W	5%	Carbon Comp.
R14	010027	100 ohm	1/4W	5%	Carbon Comp.
R15	016009	100 ohm	1/2W		Cermet Trim Pot
R17	010038	560 ohm	1/4W	5%	Carbon Comp.
R20	010042	1.2 kohm	1/4W	5%	Carbon Comp.
R23	010036	470 ohm	1/4W	5%	Carbon Comp.
R25	010048	3.3 kohm	1/4W	5%	Carbon Comp.
R27	010064	56 kohm	1/4W	5%	Carbon Comp.
R28	010189	1.2 kohm	2W	5%	Carbon Comp.
R39-44	010123	2.7 kohm	1/2W	5%	Carbon Comp.
R45	010050	4.7 kohm	1/4W	5%	Carbon Comp.
R46	010070	150 kohm	1/4W	5%	Carbon Comp.
R47	010068	100 kohm	1/4W	5%	Carbon Comp.

A6 GPIB-IEEE (705C06)

Integrated Circuits					
IC1,2	031004	MC8T97P	Tri-State Buffer		
IC3,4	031003	8T26AN	Inv. Buffer		
IC5	031005	MC68488P	GPIA		
IC6-9	031001	MC3448AP			
IC10	030004	SN7404N			
IC11	030003	SN7400N			
Capacitors					
C1	001025	0.1 uF	50V	Ceramic	
C2	001024	0.01 uF	50V	Ceramic	
Resistors					
R1-7	010049	3.9 kohm	1/4W	5%	Carbon Comp.
Switch					
S1-7	069005	7PST	DIP Switch		

A7 EPROM SELECT BOARD (705C07)

CKT. REF.	MNI PART#	DESCRIPTION AND MANUFACTURER			
Capacitors					
C1-3, 5-8	001025	0.1 uF	50WV	Monolithic	
C4	009001	22 uF	50WV	Tantalum	
Integrated Circuits					
IC1, 2	030016	SN74LS138N			
IC3	030014	SN74LS14N			
Resistors					
R1-3	010048	3.3 kohm	1/4W	5%	Carbon Comp.

A8 DVM POWER SUPPLY BOARD (705C08)

Integrated Circuits					
IC1	032011	MC7805UC	5 Volt Regulator		
Capacitors					
C1	002019	4.7 MFD	16WV	Electrolytic	
Resistors					
R1	010204	22 kohm	2W	5%	Carbon Comp.
Diodes					
D1	021005	KBF06	600V	2.5A	

A9 DISPLAY BOARD

Displays					
DS1-16	020003	LR2676R	0.6"	7 segment	

A10 MOTHER BOARD

Capacitors					
C1	002010	2.2 MFD	100WV	Electrolytic	
Inductors					
L1	044009	1 mH			

A11 G1 MODULATOR

CKT. REF.	MNI PART#	DESCRIPTION AND MANUFACTURER			
Integrated Circuits					
IC1	039004	H11A520	Opto-coupler		
Transistors					
Q1	025024	MJ413			
Q2	025011	2N3439			
Q3,4	027010	2N2405			
Diodes					
D1, 2	023002	1N5232A	5.6V	500mW	Zener
D3, 4	023019	1N5369A	51V	5W	Zener
D5	022004	1N916	100V	.200mA	Silicon
D6, 7	023023	1N5374B	75V	5W	Zener
Resistors					
R1	010111	220 ohm	1/4W	5%	Carbon Comp.
R2	010126	3.9 kohm	1/4W	5%	Carbon Comp.
R3, 12	010123	2.7 kohm	1/2W	5%	Carbon Comp.
R4	011036	150 kohm	3/4W	1%	Metal Film
R5	011037	200 kohm	2W	1%	Metal Film
R7A, B	010218	330 kohm	2W	5%	Carbon Comp.
R8	010208	47 kohm	2W	5%	Carbon Comp.
R9	010217	270 kohm	2W	5%	Carbon Comp.
R10	010128	5.6 kohm	1/2W	5%	Carbon Comp.
R11	010207	39 kohm	2W	5%	Carbon Comp.
R13	010137	27 kohm	1/2W	5%	Carbon Comp.
R14	010122	1.8 kohm	1/2W	5%	Carbon Comp.
R15	010135	18 kohm	1/2W	5%	Carbon Comp.
R16	010128	5.6 kohm	1/2W	5%	Carbon Comp.
Capacitors					
C1, 3, 5	009025	0.01 uF	50WV	Monolithic	
C2	009026	0.1 uF	50WV	Monolithic	
C4	002010	2.2 MFD	100WV	Electrolytic	
C5, 6		0.1 uF	100WV	Ceramic	

A12 G1 REGULATOR BOARD (705C12)

Integrated Circuits					
IC1	032010	MC1466L	Voltage Regulator		
Transistor					
Q1	025024	MJ413	325V	10A	
Diodes					
D3-7	021002	1N4005GP	600V	1A	Silicon
D9	023007	1N4738	8.2V	1W	Zener

A12 G1 REGULATOR BOARD (CON'T)

CKT. REF.	MNI PART#	DESCRIPTION AND MANUFACTURER			
Capacitors					
C3	001024	0.01 uF	50WV	Ceramic	
C4	001013	240 pF	1000WV	Ceramic	
C5	001010	100 pF	1000WV	Ceramic	
C6	003002	0.1 uF	600WV	Film	
C7	002013	20 MFD	500WV	Electrolytic	
Resistors					
R3	010120	1.2 kohm	1/2W	5%	Carbon Comp.
R6	010088	2.7 ohm	1/2W	5%	Carbon Comp.
R7	010111	220 ohm	1/2W	5%	Carbon Comp.
R8	010135	18 kohm	1/2W	5%	Carbon Comp.
R9	011050	8.66 kohm	1/2W	1%	Carbon Film
R10	011064	332 kohm	1W	1%	Metal Film
R11	011021	147 kohm	1/2W	1%	Carbon Film
R12	010220	470 kohm	2W	5%	Carbon Comp.
R13	010176	100 ohm	2W	5%	Carbon Comp.

A13 G1 RECTIFIER (705C13)

Diode					
D1	021011	KBU4K	800V	4A	Bridge
D2	021005	KBF06	600V	2.5A	Bridge
D8	023014	1N5359A	24V	5W	Zener
Resistors					
R1A, B	010218	330 kohm	2W	5%	Carbon Comp.
R2	010188	1 kohm	2W	5%	Carbon Comp.
Capacitors					
C1A, B	002026	47 MFD	450WV	Electrolytic	
C2	002014	47 MFD	50WV	Electrolytic	
C8	001033	0.01 uF	3000WV	Ceramic	

A14 G3 REGULATOR BOARD (705C14)

Integrated Circuits					
IC1	032010	MC1466L	Voltage Regulator		
Transistors					
Q1	025025	DTS723	750V	3A	
	or 025028	SK3710	600V	3A	
Diodes					
D3-7	021002	1N4005GP	600V	1A	Silicon
D9	023007	1N4738	8.2V	1W	Zener

A14 G3 REGULATOR (CONT'D)

CKT. REF.	MNI PART#	DESCRIPTION AND MANUFACTURER			
Capacitors					
C3	001024	0.01 uF	50WV	Ceramic	
C4	001013	240 pF	1000WV	Ceramic	
C5	001010	100 pF	1000WV	Ceramic	
C6	003002	0.1 uF	600WV	Film	
C7	002013	20 MFD	500WV	Electrolytic	
Resistors					
R3	010120	1.2 kohm	1/2W	5%	Carbon Comp.
R6	010088	2.7 ohm	1/2W	5%	Carbon Comp.
R7	010111	220 ohm	1/2W	5%	Carbon Comp.
R8	010135	18 kohm	1/2W	5%	Carbon Comp.
R9	011050	8.66 kohm	1/2W	1%	Carbon Film
R11	011063	165 kohm	2W	1%	Metal Film
R12	010220	470 kohm	2W	5%	Carbon Comp.
R13	010176	100 ohm	2W	5%	Carbon Comp.

A15 G3 RECTIFIER BOARD (705C15)

Diode					
D1	021011	KBU4K	800V	4A	Bridge
D2	021005	KBF06	600V	2.5A	Bridge
D8	023014	1N5359A	24V	5W	Zener
Resistors					
R1A, B	010218	330 kohm	2W	5%	Carbon Comp.
R2	010188	1 kohm	2W	5%	Carbon Comp.
Capacitors					
C1A, B	002026	47 MFD	450WV	Electrolytic	
C2	002014	47 MFD	50WV	Electrolytic	
C8	001033	0.01 uF	3000WV	Ceramic	

A16 G2 COARSE ADJUST BOARD (705C16)

Resistors					
R11A	011047	249 kohm	2W	1%	Metal Film
R11B-K	011046	226 kohm	2W	1%	Metal Film

A17 G2 REGULATOR BOARD (705C17)

CKT. REF.	MNI PART#	DESCRIPTION AND MANUFACTURER			
Integrated Circuits					
IC1	032010	MC1466L	Voltage Regulator		
Transistors					
Q1	025025	DTS723	750V	3A	
or	025028	SK3710	600V	3A	
Diodes					
D3-7	021002	1N4005GP	600V	1A	Silicon
D9	023007	1N4738	8.2V	1W	Zener
Capacitors					
C3	001025	0.1 uF	50WV	Ceramic	
C4	001013	240 pF	1000WV	Ceramic	
C5	001002	10 pF	1000WV	Ceramic	
C6	003004	0.1 uF	4000WV	Film	
C7	003008	0.25 uF	4000WV	Film	
Resistors					
R3	010126	3.9 kohm	1/2W	5%	Carbon Comp.
R6	010099	22 ohm	1/2W	5%	Carbon Comp.
R7	010111	220 ohm	1/2W	5%	Carbon Comp.
R8	010135	18 kohm	1/2W	5%	Carbon Comp.
R9	011050	8.66 kohm	1/2W	1%	Carbon Film
R13	010176	100 ohm	2W	5%	Carbon Comp.

A18 G2 RECTIFIER BOARD (705C18)

Capacitors					
C2	002014	47 MFD	50WV	Electrolytic	
C8, 9	001032	0.001 uF	6000WV	Ceramic	
Diodes					
D1A-D	021007	Z40S	4KV	250mA	HV Rectifier
D2	021005	KBF06	600V	2.5A	Bridge
D8	023014	1N5359A	24V	5W	Zener
Resistors					
R1A, 1B	010222	680 kohm(3)	2W	5%	Carbon Comp.
R2	010180	220 ohm	2W	5%	Carbon Comp.
R14	010208	47 kohm	2W	5%	Carbon Comp.

A19 RELAY MODULE (705C19)

CKT. REF.	MNI PART#	DESCRIPTION AND MANUFACTURER			
Capacitors					
C1	002016	470 MFD	50WV	Electrolytic	
Resistors					
R2	010132	10 kohm	1/2W	5%	Carbon Comp.
Diodes					
D2	021005	KBF06	600V	2.5A	Bridge
D8	021002	1N4005GP	600V	1A	Silicon
Integrated Circuits					
IC1	032018	MC7824CT	24V Regulator		
Transistor					
Q1	025006	2N3055	60V	15A	NPN, Power
Relays					
K1	047013	26NO120T	Amperite Time Delay		
K2,3,6,8	047011	HP11D-24VDC	Potter & Brumfield	DPDT	
K4	047009	645U-2C-24D	Guardian	DPDT	

A20 METER BOARD (705C20)

Resistors					
R1, 2	011048	6 Mohm	3W	1%	Metal Film
R3, 4	011041	1 Mohm	1W	1%	Metal Film
R5	010081	1 ohm	1/2W	5%	Carbon Comp.
R6, 8	016007	10 kohm	1W	10%	Trimmer
R7, 9	011006	1 kohm	1/2W	1%	Carbon Film

A21 CATHODE SUPPLY FEEDBACK BOARD (705C21)

Capacitors					
C1,2	011032	0.001 uF	6000WV	Ceramic	
C3A-C	001034	4.7 pF	6000WV	Ceramic	
Diodes					
D1,2	022003	1N914	100V	200mA	Silicon
Resistors					
R1A-C,3A-C	011040	464 kohm	1W	1%	Metal Film
R2	011062	412 kohm	1W	1%	Metal Film
R4	011061	365 kohm	1W	1%	Metal Film

A22 PASS TUBE GRID SUPPLY BOARD (705C22)

CKT. REF.	MNI PART#	DESCRIPTION AND MANUFACTURER			
Capacitors					
C6, 7	002011	10 MFD	450WV	Electrolytic	
Diodes					
D4A-D, 6A-D	021010	1N4007	100V	1A	Power
D3, 5	023023	1N5374B	75V	5W	Zener
Resistors					
R11	010207	39 kohm	2W	5%	Carbon Comp.
R12	010152	470 kohm	1/2W	5%	Carbon Comp.
R13, 15	010216	220 kohm	2W	5%	Carbon Comp.
R14	010200	10 kohm	2W	5%	Carbon Comp.

A23 HEATER AND CATHODE SUPPLY BOARD (705C23)

Capacitors					
C2, 4	001033	0.01 uF	3000WV	Ceramic	
C10	001029	0.005 uF	3000WV	Ceramic	
Diodes					
D1, 2	021007	Z40S	4 kV	250mA	HV Rectifier
D3, 4	023029	1N5342B	6.8V	5W	Zener
Fuses					
F5	076013	1.5 Amp	3AG	Slo-Blo	
Resistors					
R1, 2	011045	2 Mohm	2W	5%	Metal Film
A3	012020	20 kohm	12W	5%	Wire Enamel
R4	012003	1 ohm	10W	5%	Wire Ceramic
R5	012005	5 ohm	10W	5%	Wire Ceramic

A24 MANUAL EPROM (705C24)

Integrated Circuits		
IC8	033001	HN462732G

A25 LED DRIVER BOARD (705C25)

CKT. REF.	MNI PART#	DESCRIPTION AND MANUFACTURER			
Diodes					
D1, 2	023003	1N5235A	6.8V	500mW	Zener
D3, 4	022003	1N914	100V	200mA	Silicon
D5	023028	1N4733A	5.1V	1W	Zener
Resistors					
R1	010192	2.2 kohm	2W	5%	Carbon Comp.
R2, 5, 7	010189	1.2 kohm	2W	5%	Carbon Comp.
R3	010136	22 kohm	1/2W	5%	Carbon Comp.
R4	010148	220 kohm	1/2W	5%	Carbon Comp.
R6	010119	1 kohm	1/2W	5%	Carbon Comp.
R8	010190	1.5 kohm	2W	5%	Carbon Comp.
R9	010110	180 ohm	1/2W	5%	Carbon Comp.
R10	010188	1 kohm	2W	5%	Carbon Comp.
Transistors					
Q1	029003	2N6427	NPN Darlington		

A26 OVERLOAD RELAY ASSEMBLY (705A26, ON SIDE OF CARD GUIDE)

Relays				
K7	047001	Sigma 5F-10000S-SIL	0.2mA	G2 Overcurrent
K9	047002	Sigma 48F-1000G-SIL	3.2mA	G3 Overcurrent
K11	047003	Sigma 41F-500S-SIL	4mA	Cathode/Helix Overcurrent
K12	047007	Guardian 640U-C-24A	24V	Slave Overload

A27 MANUAL F1-F2 BOARD (705C27)

Integrated Circuits					
IC1	030034	534JD			
Resistors					
R1	010051	5.6 kohm	1/4W	5%	Carbon Comp.
R2-7	010127	4.7 kohm	1/2W	5%	Carbon Comp.
R8	016023	2 kohm	1/2W	10%	Trimmer
R9	010027	100 ohm	1/4W	5%	Carbon Comp.

MAIN MOUNTING PLATE

Power Supplies

PS-1 (LOT-X-5152-A)	Lambda Regulated Supply (+/-12V and +5V)
PS-2	Wanlass C3003 G2 Line Voltage Regulator

Diode

	1N4752 Zener 33V, 1W (on K10 relay)

Relay

K10	Magnecraft W158 HVX-1

Transformers

T1A	Forest Electric Co. Type DL455
T2C	Forest Electric Co. Type DJ407

Tube

V2	Ballast tube Amperite 16-4

SWITCHES

High Voltage Section

Main Power	S1	DPDT	STV-206N-0	(Alco)
H. V. (on/off)	S2	DPDT	MST-205N	(Alco)
G2 H.V. (on/off)	S3	DPDT	MST-205N	(Alco)
Overload Reset	S4	SPDT (momen.)	MTA106F	(Alco)
Top Cover Interlock	S5	SPDT (momen.)	E33-01K	(Cherry)
115V/230V	S6	4PDT	1458	(Centralab)
Meter Selector	S7	2P 5 position	2505	(Centralab)
G2 Coarse	S8	4P 4 position	2515	(Centralab)

Microprocessor Section

Reset	S1	SPDT (momen.)	MTA-106F	(Alco)
Markers	S3	73L1G040P103W (Mounted on Marker Ampl'd Pot)		(Allen-Bradley)
Manual Trigger	S4	SPDT (momen.)	MTA-106F	(Alco)
CW Source	S5	2P 5 position	PA-6003	(Centralab)
Mode	S6	6 pole, 4 pos.	51091	(Standard & Grigsby)
Sweep Range	S7	SP 3 position	49785-4MLR-1	(Standard & Grigsby)
Trigger Mode	S8	SP 4 position	PA6003	(Centralab)
Modulation	S9	2P 3 position	49785-4MLR-1	(Standard & Grigsby)
Crystal Polarity	S10	SPDT	CES-16D	(Alco)
Level Unlevel	S11	SPDT	49785-4MLR-1	(Standard & Grigsby)
Blanking On/Off	S12	SP 2 position	Part of 51091	(Standard & Grigsby)

REAR PANEL

Fuses	115V	(220V)		
F1	3A	(1-1/2)	3AG	Slo-Blo
F2	2A	(1)	3AG	Slo-Blo
F3, F4	1A	(1/2)	3AG	Slo-Blo

Line Filter	CEE-22	Feller AG	8843, N4.20	
Switch	S2	Blanking Relay	SPDT	Alco MST-105D
Resistors	470 kohm, 2W		5%	Carbon Comp (On J1)
Heater Adjust	25 ohm, 25W, wirewound pot			

FRONT PANEL

Indicators

I1	Power	CM4-23	LED	Red diffused
I2	HV	MV-5491	LED	Red/Green
I3	G2HV	MV-5491	LED	Red/Green
I4	Thermo/Interlock	FRL4403	LED	Red flashing
I5	Overload	FRL4403	LED	Red flashing
I6	Sweep	CM4-23	LED	Red diffused
I7	F1>F2	CM4-23	LED	Red diffused
I8	F1 shows Freq.	CM4-23	LED	Red diffused
I9	Remote	CM4-23	LED	Red diffused
I10	Unleveled	CM4-23	LED	Red diffused

Meter

M1	Digital Voltmeter		Datel	DM-4100L

Potentiometers

R1	Sweep Rate	10kohm CCW Log	1/2W	73J1G200R103B
R7	Power Level	1 kohm	2W	73BIG200R102W
R2	Mod. Freq.	10 kohm	2W	73BIG200R103W
R3, R4	F1, M1, M2,			
R5, R6	F2	10 kohm 10 T	2W	
A11R6	G1 Adj.	200 kohm 10 T	2W	
A14R10	G3 Adj.	250 kohm 10 T	2W	
R10	G2 Adj.	500 kohm 10 T	5W	
R8	Min. Power	250 ohm Trim pot	1/2W	
R9	Sensitivity	2.5 kohm Trim Pot	1/2W	
R10	Marker Ampl'd	10 kohm (CW switch)	2W	73L1G040P103W
R11	F1-F2 Manual	10 kohm	2W	73BIG200R103W

CENTER DIVIDER PANEL (Part of Cathode Supply)

V1	Pass Tube	Eimac	4CX250B
C1, C3	Capacitors	2MF	2KV oil filled Bycap Corp.
T4	DVM Transformer		M138-103

RIGHT SIDE PANEL

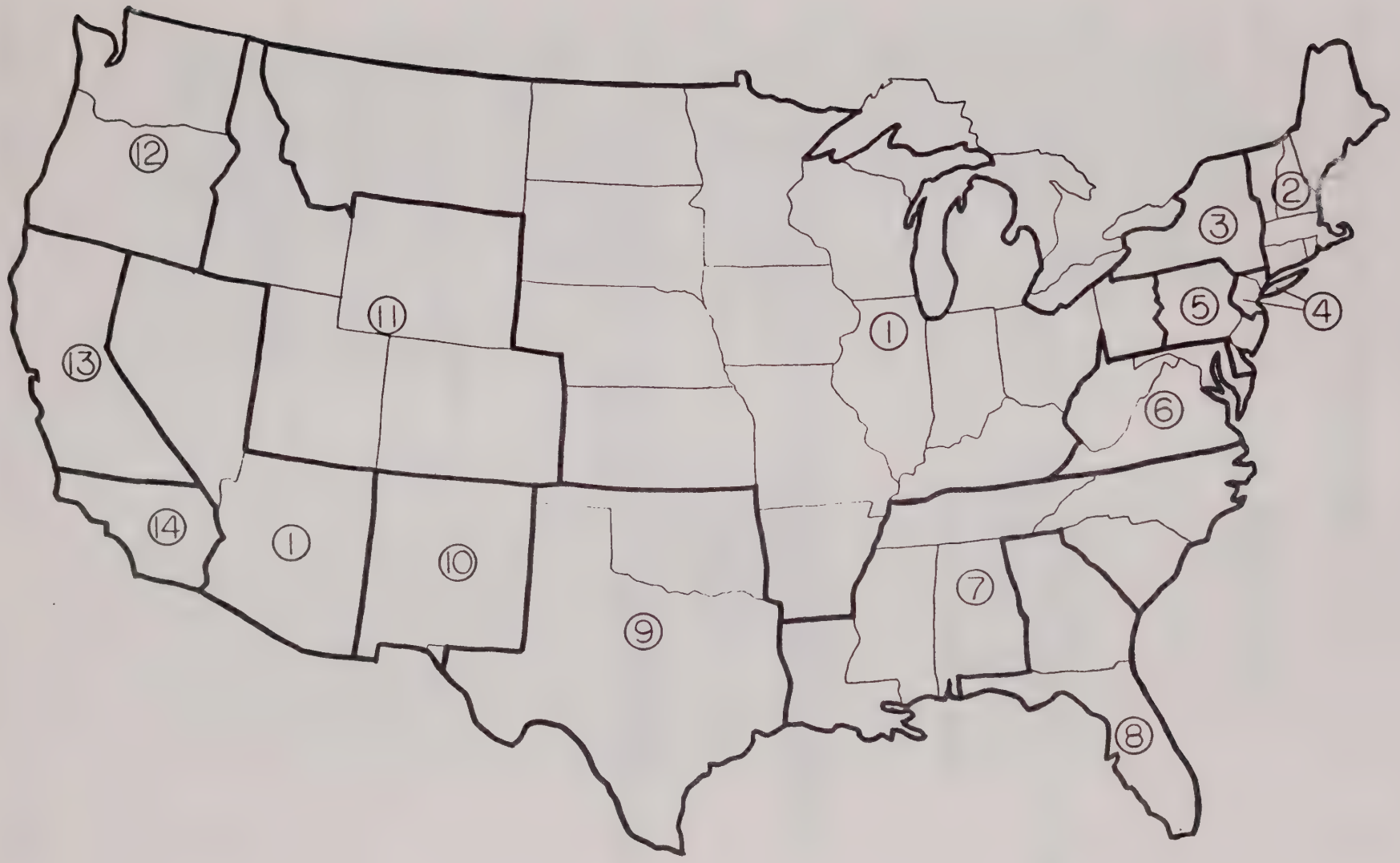
Meter Board	See Unit A20	
T3B	G2 Transformer	M136-101
A26	HV Card Guide Assembly	

SECTION 9 SALES AND SERVICE REPRESENTATIVES

9.0 SALES AND SERVICE REPRESENTATIVES:

9.1 United States.

9.2 Foreign.



UNITED STATES SALES AND SERVICE REGIONS
FIGURE 9.0

9.0 SALES AND SERVICE REPRESENTATIVES:

9.1 United States.

AREA 1 (AR, AZ, IA, IL, IN, KS, KY, MI, MN, MO, MT, ND, NE, NV, OH, WESTERN PA, SD)

Micro-Now Instrument Co., Inc.
8260 N. Elmwood Avenue
Skokie, IL 60077
312/677-4700

AREA 2 (CT, MA, ME, NH, RI, VT)

Pat Jenks Associates
50 S. Main St. Suite 106
Wallingford, CT 06492
203/265-9939

Pat Jenks Associates
400 W. Cummings Park Suite 4250
Woburn, MA 01801
617/938-0488

AREA 3 (NY {NORTH OF WESTCHESTER/ROCKLAND COUNTY LINES})

Ossmann Instruments, Inc.
6666 Old Collamer Rd.
East Syracuse, NY 13057
315/437-7052

AREA 4 (NORTHERN NJ {INCLUDING MERCER AND MONMOUTH COUNTIES}, SOUTHERN NY {INCLUDING WESTCHESTER AND ROCKLAND})

US Technical Marketing
11 Columbine Lane
Kings Park, NY 11754
516/724-4250

Sy Letzter
11 Debbie Lane
E. Windsor, NJ 08520
609/448-4813

AREA 5 (DE, SOUTHERN NJ {INCLUDING BURLINGTON AND OCEAN}, EASTERN PA {INCLUDING POTTER, CAMERON, CLINTON, CENTRE, HUNTINGDON, AND FRANKLIN})

Robert Meyers Associates
613 W. Cheltenham Ave.
Melrose Park, PA 19126
215/224-1663

AREA 6 (MD, VA, WV, WASHINGTON D.C.)

Q. T. Marketing & Sales
6206 Julian St.
P.O. Box 555
Springfield, VA 22150
703/941-4242

AREA 7 (AL, LA, MS, NC, SC, TN)

W. A. Brown Instruments
4410C Evangel Circle
P.O. Box 11037
Huntsville, AL 35816
205/830-9224

AREA 8 (FL, GA)
The Snow Company
3109 N. E. 25th St.
Ft. Lauderdale, FL 33305
305/563-2448

AREA 9 (OK, TX {EXCEPT EL PASO COUNTY})
Texas Avionics
13773 N. Central Expressway
Suite 1630
Dallas, TX 75243
214/368-3566

AREA 10 (NM, TX {EL PASO COUNTY ONLY})
IMEC
4613 Comanche, N. E.
Albuquerque, NM 87110
505/883-9010

AREA 11 (CO, ID, UT, WY)
Herb Bass Associates
5225 N. 51st St.
Boulder, CO 80301
303/530-7509

AREA 12 (OR, WA)
Datacom Associates
1616 Bigelow Ave., N.
Seattle, WA 98109
206/285-2525

AREA 13 (NORTHERN CA {BOUNDED BY SAN LUIS OBISPO, KERN, AND SAN BERNARDINO COUNTIES})
Mark V Associates
147 Castro St. Suite 2B
P.O. Box 669
Mountain View, CA 94041
415/964-6275

AREA 14 (SOUTHERN CA {INCLUDING SAN LUIS OBISPO, KERN, AND SAN BERNARDINO COUNTIES})
McDougall/McLaughlin Co.
1539 Sawtelle Blvd. #16
Los Angeles, CA 90025
213/477-8556

U.S. Foreign

[illegible]
Editor, Fleetwood
Owner, Vice Pres. Inc. Stes. I
Pres., Mgr., Exec. Merchan
Vice Pres., Secretary
[illegible]
[illegible]

[illegible]
Bonnie Corporation
[illegible] Ridge Road
[illegible]
[illegible]
[illegible]

Orlando [illegible] Blvd. Ste.
[illegible] Lake Worth Corr. Hwy.
Seattle, W[illegible]
[illegible]
Telex: [illegible]

FRANCE

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
Telex: [illegible]

[illegible]
Ave. [illegible]
[illegible]
P.O. [illegible]
Kelbourne [illegible]
[illegible]
[illegible]
Telex: [illegible]

GREAT BRITAIN

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

ISRAEL

[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]
[illegible]

9.0 SALES AND SERVICE REPRESENTATIVES (CONT'D):

9.2 Foreign.

AUSTRIA
Kontron Phystech
Oskar von Miller Str. 1
8057 Eching bei Munchen
West Germany
(08165) 77-0
Telex: 526795

CHINA
Dorado Corporation (P.R.C.)
15 Zhong Shan Road (E1)
Shanghai, China (P.R.C.)
219-103
Telex: 33175 CGWSH CN

Dorado Corporation (P.R.C.)
419 Lake Washington Blvd.
Seattle, WA 98122
206/583-0000
Telex: 880212 DORADOCO UD

FRANCE
Matech
3 Avenue Charles De Gaulle
94470 Boissy St. Leger
France
1-569-5220
Telex: 206961 MATECH F

HOLLAND
Air Parts Electronics
2400 ag alphen aan den rijn
P.O. Box 255
Kalkovenweg 12
Holland
(1720) 43221
Telex: 39564 API NL

GREAT BRITAIN
Daltron, Limited
114 High Street South
Dunstable, Bedfordshire
LU6 3AX
Great Britain
0582-605278
Telex: 825120 DALTRO G

ISRAEL
Applied Technologic Services, Ltd.
33 Ben Gurion St.
P.O. Box 5085
Herzliya 46 101
Israel
Tel: 052-574111
Telex: 341787 ATS IL
Fax: 972-52-574447

ITALY
Sematron S.R.L.
4 Via Alfredo Panzini
00137 Roma
Italy
Telex: 610275 PPRMAP I

JAPAN
Nanowave Corp.
Wakoh Shinjuku Plaza 2F
No. 7-26 Nishi Shinjuku 7 Chome
Shinjuku-Ku, Tokyo 160
Japan
Telex: J24171 ASTECH J

SOUTH AFRICA
Urardu Electronics (Pty) Ltd.
P.O. Box 30323
Sunnyside, Pretoria 0132
South Africa
(012) 98-3096/98-1919
Telex: 3-0581

SWITZERLAND
Kontron Electronic AG
8010 Zurich
Bernerstrasse Sud 169
Switzerland
01/435 41 11
Telex: 822 195

TAIWAN
Schmidt Scientific
5th Fl. Cathay Commercial Bldg.
344 Min Sheng E. Road
Taipei, Taiwan
Taipei: 5013468
Telex: 11111 SCHMIDT

WEST GERMANY
K+C Engineering
c/o Wacker GMBH
6000 Frankfurt/Main
West Germany
69-725045
Telex: 841-416448 WAKEX D

MP MASTER
MA32959